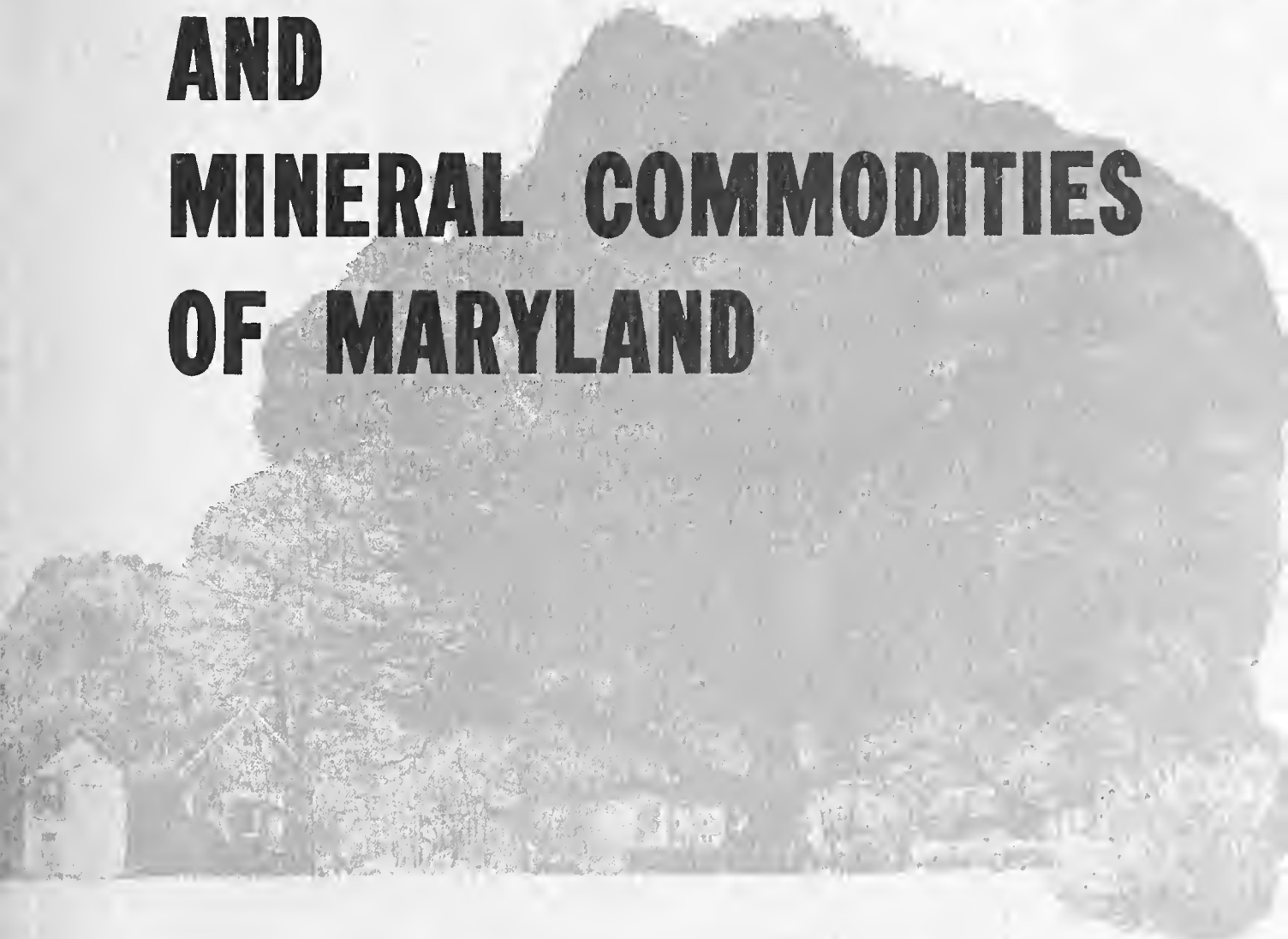
STATE DEVELOPMENT PLANNING SERIES

GROUND-WATER AQUIFERS AND MINERAL COMMODITIES OF MARYLAND



MARYLAND STATE PLANNING DEPARTMENT
MARYLAND GEOLOGICAL SURVEY
U.S. DEPARTMENT OF THE INTERIOR-GEOLOGICAL SURVEY

Wye Oak, pictured on the cover, is the official State tree of Maryland. Located in Wye Mills on Maryland's Eastern Shore, this magnificent white oak is one of the largest in the United States. It was over 100 years old when Leonard Calvert led Maryland's first colonists ashore in March of 1634. Photograph courtesy of Maryland Department of Economic Development.

The Aquifer section of this report was prepared by the U. S. Department of the Interior in cooperation with the Maryland Geological Survey and the Maryland State Planning Department.

The Mineral Commodities section of this report was prepared by the Maryland Geological Survey in cooperation with the Maryland State Planning Department.

The preparation of this document was financially aided through a Federal grant from the Department of Housing and Urban Development under the Urban Planning Assistance Program Authorized by Section 701 of the Housing Act of 1954, as amended.

MARYLAND STATE PLANNING DEPARTMENT
STATE OFFICE BUILDING
BALTIMORE, MARYLAND 21201

Publication No. 152 May 1969

GROUND-WATER AQUIFERS AND MINERAL COMMODITIES OF MARYLAND

STATE OF MARYLAND

Marvin Mandel, Governor

Maryland State Planning Department

Vladimir A. Wahbe, Director

Maryland Geological Survey

Kenneth Weaver, Director

Table of Contents

List of Maps

STATE OF MARYLAND

PLANNING DEPARTMENT

STATE OFFICE BUILDING

VLADIMIR A. WAHBE
DIRECTOR

301 W. PRESTON ST.
BALTIMORE, MD. 21201

TELEPHONE: 383-3010

May 1, 1969

Honorable Marvin Mandel
Governor of Maryland
The State House
Annapolis, Maryland

Dear Governor Mandel:

I am pleased to transmit the enclosed report entitled Groundwater Aquifers and Mineral Commodities of Maryland. This report is another in the series being developed as part of the Statewide Planning Program administered by this Department. The technical aspects of this study were undertaken by the Maryland Geological Survey in cooperation with the Geological Survey, U. S. Department of the Interior.

The aquifer and mineral material presented in this report will be useful for a wide variety of planning activities and information requirements. This document also includes information concerning important non-renewable mineral resources of the State.

It is felt that this study will be useful not only in the Statewide planning process but will also be valuable to many individuals, organizations, agencies, and departments both public and private. Copies of this report are being distributed throughout the State.

Sincerely,

Vladimir Wahbe

Vladimir Wahbe
Director

INTRODUCTION

The maps contained in this report show the statewide distribution of the significant mineral and ground-water resources of Maryland. The maps were compiled from either published or open-filed data and, therefore, do not represent new geologic data and information. Because the report was designed to provide a rapid, albeit generalized, overview of where the State's natural resources are located, its chief utility is for geographic reference, rather than economic appraisal or engineering design. For example: although one of the maps shows the surface distribution of limestone formations in the State, it does not provide the detailed chemical or mineralogic information needed for commodity decisions. Similarly, the aquifer maps do not comment directly upon questions of water quality or yield at a specific site. Where data permit, the maps do, however, show which aquifers occur beneath an area by giving (in the case of the Coastal Plain) their approximate depth of occurrence. If more specific detail is required, the Maryland Geological Survey or its publications should be consulted.

There are ten aquifer maps. Maps I and II cover the Piedmont and Appalachian regions, occurring west of the Fall Line. The remaining eight maps show the known outcrop and subsurface distribution of the major Coastal Plain aquifers. The mineral commodities of the State are shown on Maps XI through XVI.

The geologically complex rocks of the Piedmont and Appalachian provinces are categorized into three hydrologic units, depending upon their productive capacities. For example, the geologic formations constituting Unit I have approximately a 20 percent chance of yielding 50 gpm (gallons per minute) or more; on the other hand, this probability is reduced to 6 percent and 2 percent in Units II and III respectively. These are, of course, statistical inferences and

provide only a very generalized representation of the water-yielding characteristics of the rocks. Local geologic anomalies can substantially alter these relationships.

The Coastal Plain aquifers occur as a series of irregularly shaped wedges that gently dip, generally less than 1°, to the south and east. The upper truncated edges of these formations outcrop as a series of concentric bands. These are, from west to east, the Patuxent Formation, Patapsco-Raritan (undivided) Formation, Magothy Formation, Aquia Greensand, Piney Point Formation, Manokin Aquifer and Pocomoke Aquifer. The latter two are everywhere buried beneath a surficial mantle of Plio-Pleistocene sands and gravels. Map X is a structure contour map showing the depth to the base of the Plio-Pleistocene sediments. Deep, linear areas on this map represent both recent (Susquehanna and Choptank) and ancestral (near Salisbury and Berlin) river channels; the thick, permeable nature of the latter is highly favorable for large capacity wells.

Except in their outcrop areas, all of the formations shown in Maps III to IX function as artesian aquifers. At the outcrop water-table conditions prevail. Under natural conditions the outcrop belts function as recharge areas in upland localities and discharge areas in lowland localities.

The Piney Point aquifer, which does not outcrop, is recharged by leakage through confining beds. Other major subsurface boundaries of this type are shown on the Aquia and Magothy maps.

The Patuxent and Patapsco-Raritan (undivided) Formations are multi-aquifer units. Although boundaries within these formations may be locally important, their complexity prevents a representation at the published map scale.

The six mineral-resource maps illustrate the general areas of occurrence of mineral commodities which are economically important to the State. Specific

localities for mineral-producing operations within these generalized areas are determined by many factors including chemical quality and physical properties of the materials, the topography and ground-water conditions at the site, access to the site and its proximity to a ready market, and the value of the land relative to other uses.

Over 90 percent of the value of mineral production in Maryland is contributed by the production of sand and gravel, crushed stone and cement - materials of basic importance to the building and construction industries. Sand and gravel which is shown on Map XIII generally is limited to the Coastal Plain with the best deposits occurring along the western edge. On the other hand, Map XI shows that materials suitable for crushed stone are found in the Piedmont and Appalachian regions of central and western Maryland. Carbonate rocks as portrayed on Map XIII represent a special case of crushed stone in which the chemical quality is of more importance than the physical properties for such uses as cement and lime manufacture.

Clays and shales occur throughout the State, ranging from unconsolidated clays in the Coastal Plain to consolidated shales in the Piedmont and Appalachian regions. Map XIV depicts clays and shales.

The occurrence of the mineral fuels, coal and natural gas, in Maryland is confined to the western part of the State. Geological tests in the Coastal Plain have not found any indications of petroleum or natural gas in that region. Mineral fuels information is shown on Map XV.

Miscellaneous mineral deposits as shown on Map XVI include talc and soapstone, high-silica sand, greensand, and diatomaceous earth. Present operations in these materials are small but there is future growth potential.

Ground-water Aquifers of Maryland

U.S. Department of The Interior -
Geological Survey

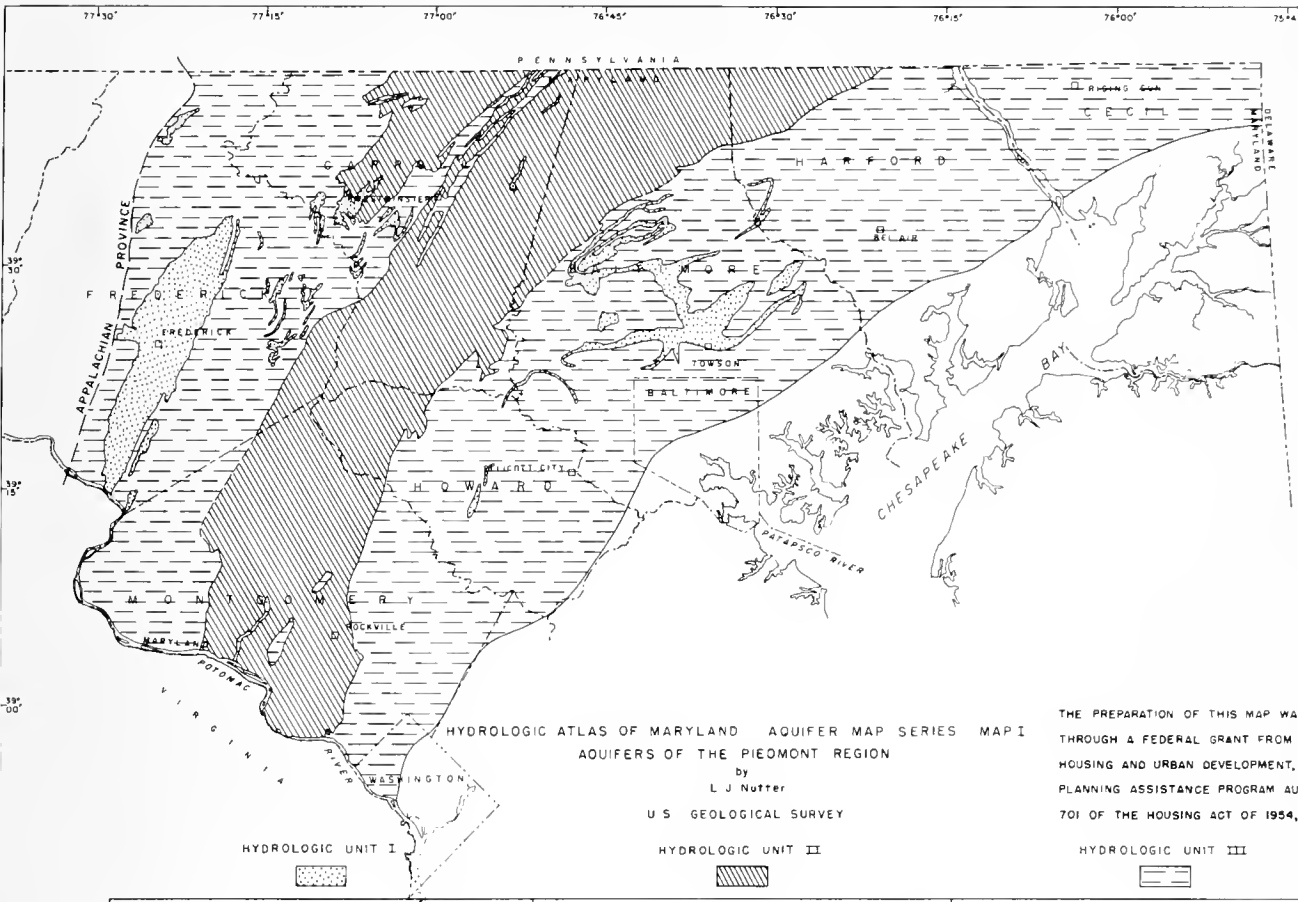
In Cooperation with the

MARYLAND GEOLOGICAL SURVEY

PIEDMONT AND APPALACHIAN REGIONS

The statistical data presented in Aquifer Map Series I and II were originally compiled for both the Piedmont and Appalachian regions combined. The data were presented on two maps in order to present a more convenient size illustration. The legends on the two maps are identical except that only the geologic units (formations) within each region are included on the map of that region.

It should be emphasized that within any one of the three hydrologic units defined on Aquifer Map Series I and II, extreme variability in yields of individual wells exists. This variability results in part from the fact that factors such as the topographic position of well sites and geologic structure which cause jointing and fracturing in the rocks also determine the amount of water an individual well will yield. The evaluation of specific water supply problems must consider these factors as well as the geologic formation outcropping at a given locality.



HYDROLOGIC ATLAS OF MARYLAND AQUIFER MAP SERIES MAP I

AQUIFERS OF THE PIEDMONT REGION

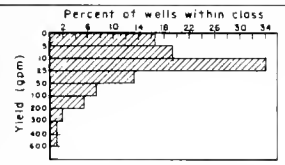
by

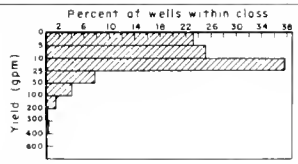
L J Nutter

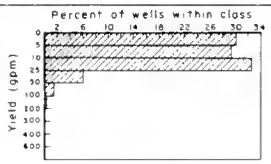
U S GEOLOGICAL SURVEY

THE PREPARATION OF THIS MAP WAS FINANCIALLY AIDED THROUGH A FEDERAL GRANT FROM THE DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT, UNDER THE URBAN PLANNING ASSISTANCE PROGRAM AUTHORIZED BY SECTION 701 OF THE HOUSING ACT OF 1954, AS AMENDED

HYDROLOGIC UNIT I	HYDROLOGIC UNIT II	HYDROLOGIC UNIT III
Limestones of the Frederick Valley including: Grove Ls and Frederick Ls Marbles of the Piedmont including Wakefield Marble and Cockeysville Marble	Schists and quartzites of the central Piedmont including Marburg Schist and Wissahickon Fm (Micaceous qtzte member and Upper pelitic schist member)	Shales, sandstones, and conglomerates of the Triassic lowland including: Gettysburg Sh and New Oxford Fm Phyllites, schists, and metavolcanic rocks of the western Piedmont including metabasalt and metarhyolite, Ijamsville Fm, and Urbana Phyllite Schists, gneisses, and intrusive rocks of the eastern Piedmont including: granite, granodiorite, gabbro, and metagabbro, Wissahickon Fm (Boulder gneiss member and Lower pelitic schist member), Setters Fm, and Baltimore Gneiss.
Hydrologic Unit I contains the most productive aquifers within the areas of this map. It includes those formations in which the average well yields and specific capacities fall in the upper 25 percent of a list of formations ranked according to their water-yielding characteristics The yields of wells range from less than 1 to about 580 gallons per minute (gpm). In this unit there is approximately a 20 percent chance of getting a well yielding 50 gpm or more, that is, 1 well out of 5 may be expected to yield 50 gpm or more The rocks in this unit are mainly carbonates subject to processes of solutional weathering and having a fair degree of permeability.	Hydrologic Unit II contains those aquifers of intermediate productivity, and includes those geologic units in which the average well yields and specific capacities fall between 25 and 50 percent of a list of formations ranked according to their water-yielding characteristics The yields of wells in this unit range from less than 1 gpm to about 320 gpm. In this unit there is about a 6 percent chance of getting 50 gpm or more that is, only 1 well in approximately 17 may be expected to yield 50 gpm or more This unit includes several different types of rocks but is intermediate in hydrologic properties as indicated by the yields of wells and their specific capacities	Hydrologic Unit III contains the poorest aquifers within the mapped area. It includes those geologic units in which the average yields and specific capacities of wells fall in the lower 50 percent of a list of formations ranked according to their water-yielding characteristics. The yields of wells in this unit range from less than 1 to 200 gpm. In this unit there is only a 2 percent chance of getting 50 gpm or more; that is, only 1 out of 50 wells may be expected to yield 50 gpm or more. This unit includes schists, phyllites, gneisses, and gabbro. Some sandstones and shales of relatively low average permeability are also included.







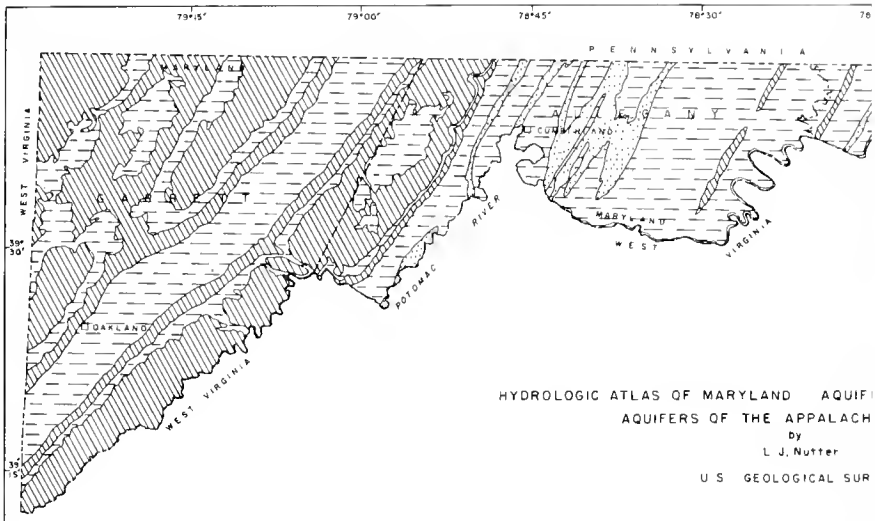
EXPLANATION

The aquifers of this area are shown on this map as three hydrologic units. Each different geologic unit has been placed into one of three hydrologic units, based upon reported specific capacities[1] and yields of wells. Publications of the Maryland Geological Survey have been the primary source of data for the map, which provides only a very generalized representation of the water-yielding character of the rocks, and should be used accordingly.

1/ Specific capacity is the yield per foot of drawdown of the water level (gpm/ft)

1967

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
in cooperation with the
MARYLAND GEOLOGICAL SURVEY



HYDROLOGIC ATLAS OF MARYLAND AQUIF

AQUIFERS OF THE APPALACH

By

L. J. Nutter

U S GEOLOGICAL SUR

THE PREPARATION OF THIS MAP WAS FIN
THROUGH A FEDERAL GRANT FROM THE D
HOUSING AND URBAN DEVELOPMENT, UNDE
PLANNING ASSISTANCE PROGRAM AUTHORI
701 OF THE HOUSING ACT OF 1954, AS A

39°00'

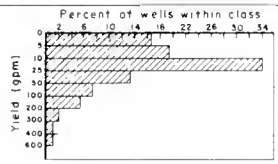
38°45'

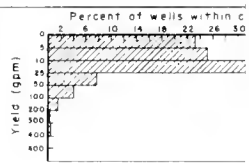
38°30'

39°15'

38°00'

HYDROLOGIC UNIT I	HYDROLOGIC UNIT II
Limestones and dolomites of the Hagerstown Valley including Beekmantown Group, Conococheague Ls, Elbrook Ls, and Tomstown Dol Sandstones and limestones of the Valley and Ridge including Oriskany Ss, Helderberg Ls, and Tonoloway Ls	Sandstones, shales, and shaley limest and Ridge and Appalachian Plateau inclu Mauch Chunk Fm, Greenbrier Ls and Poco Catoctin Metabasalt of the Blue Ridge
Hydrologic Unit I contains the most productive aquifers within the areas of this map. It includes those formations in which the average well yields and specific capacities fall in the upper 25 percent of a list of formations ranked according to their water-yielding characteristics. The yields of wells range from less than 1 to about 580 gallons per minute (gpm). In this unit there is approximately a 20 percent chance of getting a well yielding 50 gpm or more; that is, 1 well out of 5 may be expected to yield 50 gpm or more. The rocks in this unit are mainly carbonates subject to processes of solutional weathering and having a fair degree of permeability.	Hydrologic Unit II contains those aqu diate productivity, and includes those ge which the average well yields and specific between 25 and 50 percent of a list of fo according to their water-yielding charact The yields of wells in this unit range gpm to about 320 gpm. In this unit the percent chance of getting 50 gpm or mo 1 well in approximately 17 may be expec gpm or more. This unit includes widely differing ty is intermediate in hydrologic properties the yields of wells and their specific c

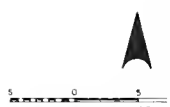




EXPLANATION

The aquifers of this area are shown on this map as three hydrologic units. Each different geologic unit has been placed into one of three hydrologic units, based upon reported specific capacities[1] and yields of wells. Publications of the Maryland Geological Survey have been the primary source of data for the map, which provides only a very generalized representation of the water-yielding character of the rocks, and should be used accordingly.

1/ Specific capacity is the yield per foot of drawdown of the water level (gpm/ft)



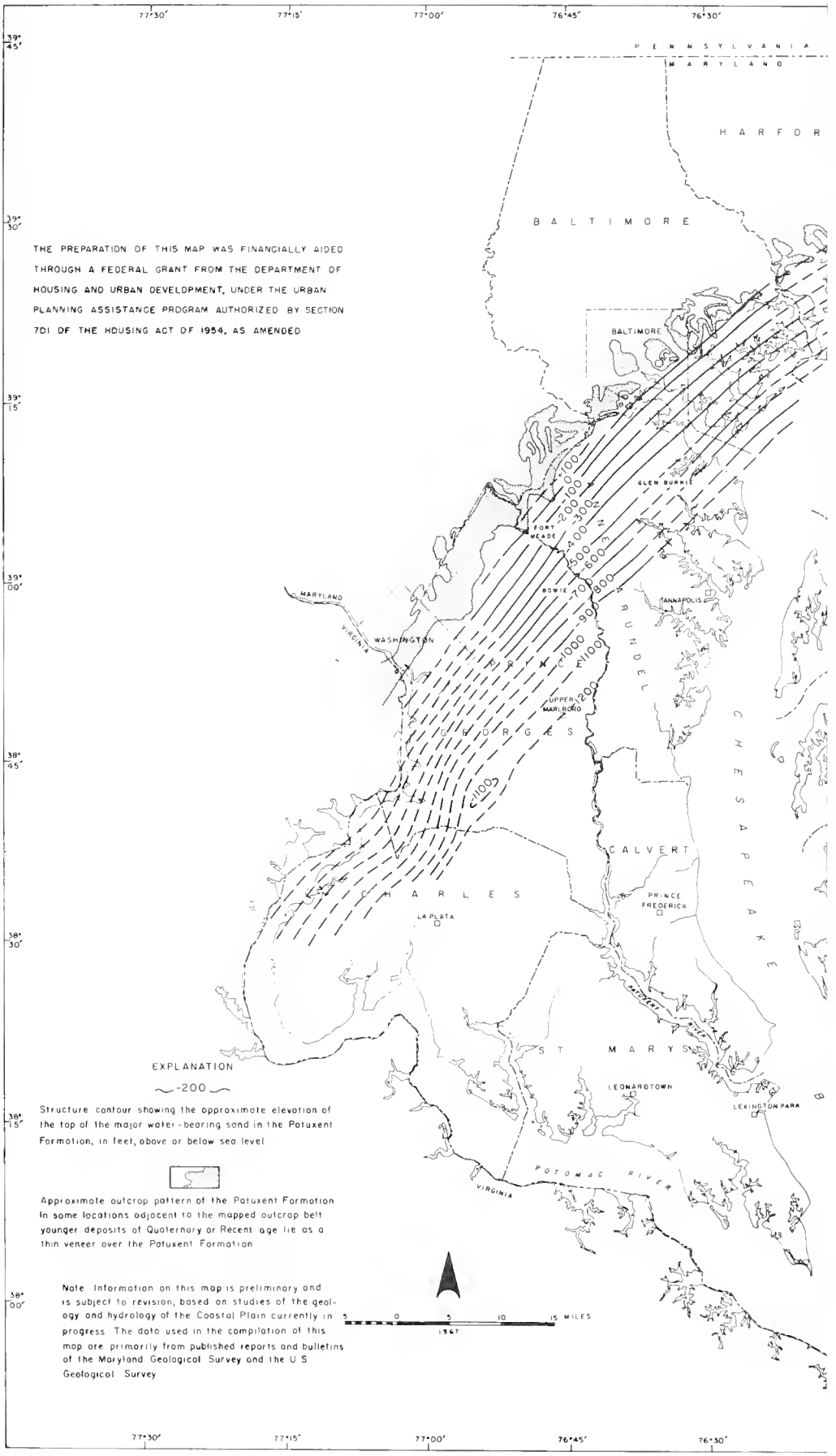
Fold out

PATUXENT FORMATION

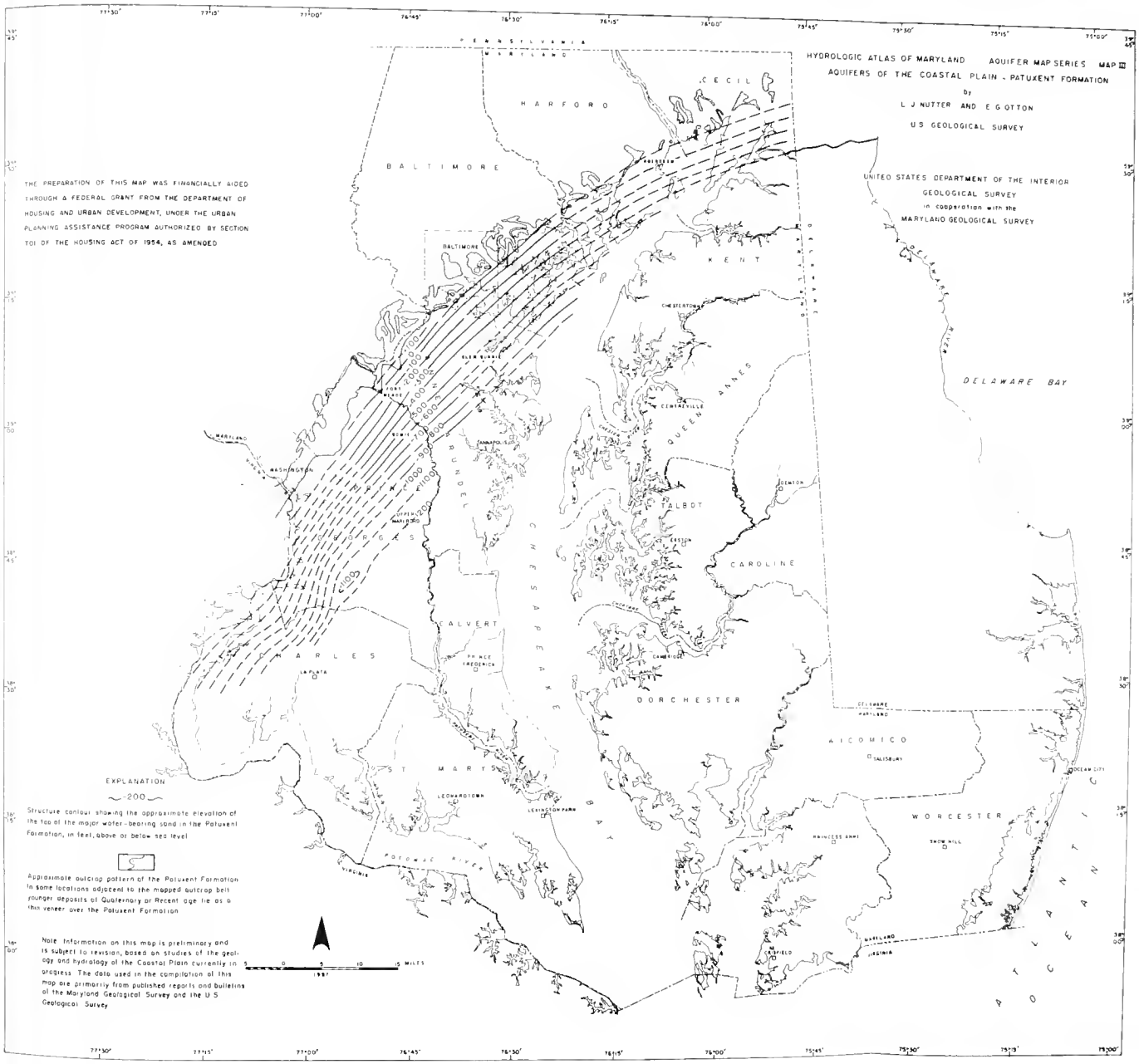
Sands in the Patuxent Formation constitute an important source of groundwater along that part of the Coastal Plain immediately southeast of the Fall Zone. The Patuxent Formation consists of irregularly stratified layers of sand, gravel, clay, and mixtures thereof. The formation ranges in thickness from a few feet in its outcrop area to as much as 2,300 feet near Ocean City. In Harford, Baltimore, Anne Arundel, and Prince George's counties, where it is most productive, the maximum thickness of the aquifer is seldom more than 350 feet. In the Baltimore area about 50 percent of the total formation thickness is reported to be water-bearing sand and gravel, but the proportion of sand and gravel decreases to the southwest toward Washington, D. C. Yields of wells in the most favorable localities range from a few hundred to as much as 1,200 gallons per minute (gpm).

The Patuxent Formation is a source of groundwater for the towns of Aberdeen, Bowie, Glen Burnie, and some of the suburban communities southeast of Washington, D. C. It furnishes important supplies of cooling water to several industries in and near Baltimore City. The water is commonly soft and of low mineral concentration, but locally it may require treatment for iron removal and/or reduction of acidity.

In many areas of the State, the Patuxent Formation is untapped and may constitute a potential source of large supplies of potable groundwater.



THE PREPARATION OF THIS MAP WAS FINANCIALLY AIDED THROUGH A FEDERAL GRANT FROM THE DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT, UNDER THE URBAN PLANNING ASSISTANCE PROGRAM AUTHORIZED BY SECTION 701 OF THE HOUSING ACT OF 1954, AS AMENDED


HYDROLOGIC ATLAS OF MARYLAND AQUIFER MAP SERIES MAP III
AQUIFERS OF THE COASTAL PLAIN - PATUXENT FORMATION
by
L J NUTTER AND E G OTTON
U S GEOLOGICAL SURVEY
UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
in cooperation with the
MARYLAND GEOLOGICAL SURVEY
THE PREPARATION OF THIS MAP WAS FINANCIALLY AIDED THROUGH A FEDERAL GRANT FROM THE DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT, UNDER THE URBAN PLANNING ASSISTANCE PROGRAM AUTHORIZED BY SECTION 701 OF THE HOUSING ACT OF 1954, AS AMENDED
PENNSYLVANIA
MARYLAND
CECIL
HARFORD
BALTIMORE
BALTIMORE
KENT
DELAWARE
DELAWARE BAY
CHESTERTOWN
QUEEN ANNES
CENTREVILLE
TALBOT
EASTON
CAROLINE
CHESAPEAKE BAY
CALVERT
CHARLES
LA PLATA
ST MARYS
DORCHESTER
CAMBRIDGE
WICOMICO
SALISBURY
WORCESTER
OCEAN CITY
PRINCESS ANNE
SNOW HILL
LEONARDTOWN
LEXINGTON PARK
POTOMAC RIVER
VIRGINIA
MARYLAND
VIRGINIA
ATLANTIC
OCEAN
EXPLANATION
-200
Structure contour showing the approximate elevation of the top of the major water-bearing sand in the Patuxent Formation, in feet, above or below sea level
Approximate outcrop pattern of the Patuxent Formation In some locations adjacent to the mapped outcrop belt younger deposits of Quaternary or Recent age lie as a thin veneer over the Patuxent Formation
Note Information on this map is preliminary and is subject to revision, based on studies of the geology and hydrology of the Coastal Plain currently in progress The data used in the compilation of this map are primarily from published reports and bulletins of the Maryland Geological Survey and the U S Geological Survey
0 5 10 15 MILES
1957

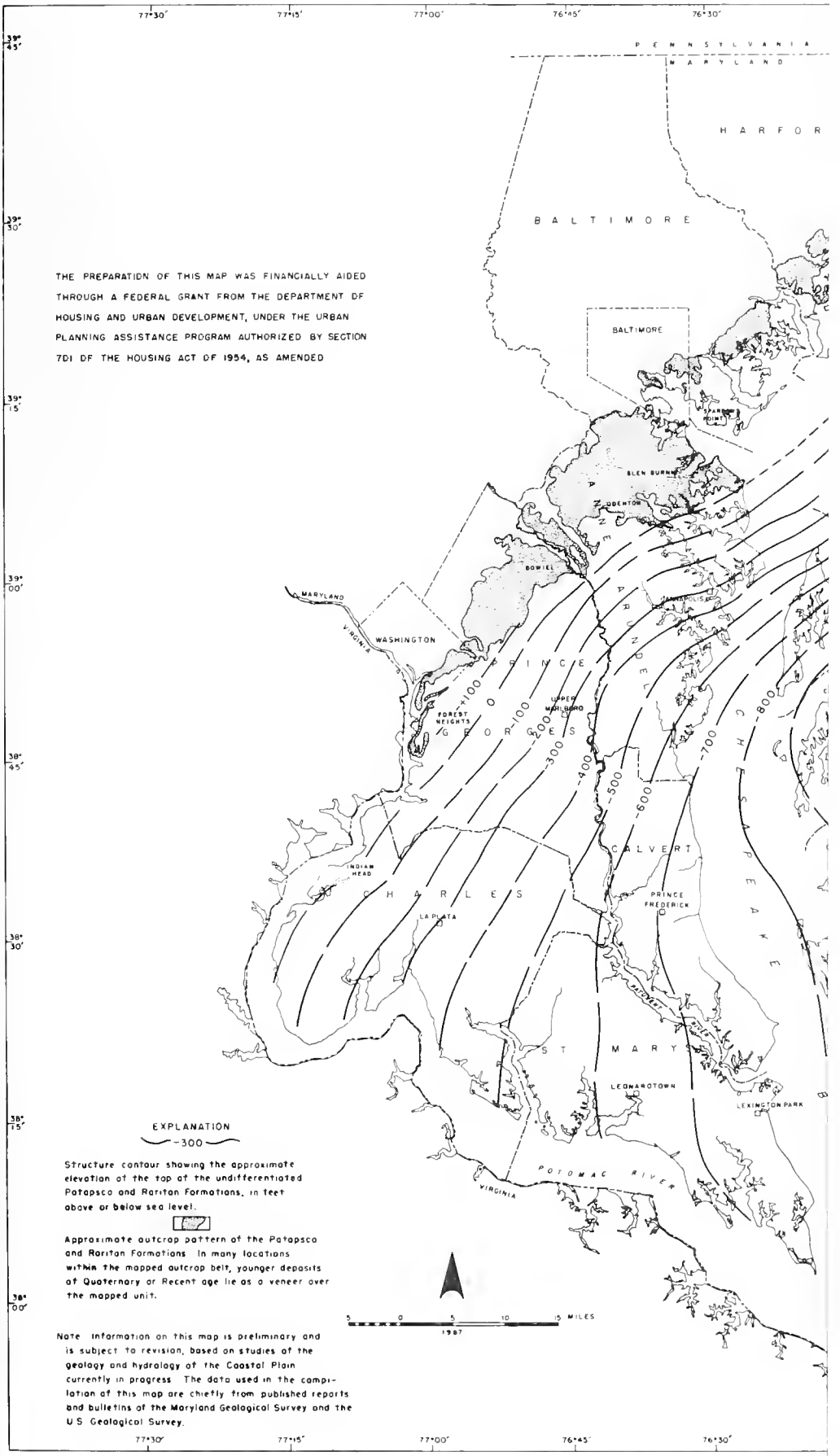
PATAPSCO AND RARITAN FORMATIONS

Water-bearing sands in the undifferentiated Patapsco and Raritan Formations comprise the most widely used aquifers in the Maryland Coastal Plain. These formations consist of irregularly stratified layers of variegated gravel, sand, silt, and clay in varying proportions. Clayey sediments tend to predominate in the Raritan Formation and sandy sediments are most common in the Patapsco Formation. The thickness of the combined units ranges from a few feet in the outcrop area to more than 500 feet near Claiborne. The thickness probably increases to more than 1,000 feet at Salisbury. At Sparrows Point, where the formations are approximately 300 feet thick, about one-third of the strata consist of water-bearing sand and gravel. The proportion of sand decreases toward the southwest near the Washington, D. C. area. Yields of wells range from less than 100 to 2,160 gallons per minute (gpm) although wells yielding more than 1,000 gpm are considered exceptional. The most productive well is in the Bowie area in Prince Georges County.

The Patapsco and Raritan Formations are a source of groundwater for the towns of Annapolis, Glen Burnie, Odenton, Forest Heights, Indian Head, and Bowie.

Many industries in the Baltimore area use cooling water obtained from these aquifers. The chemical quality of the water is generally good, but locally treatment for iron removal and de-acidification is required.

Large additional ground-water supplies are available for development from the Patapsco and Raritan Formations. In the northern counties of the Eastern Shore the cost of treatment of the water may be a factor limiting the local use of the aquifers.



THE PREPARATION OF THIS MAP WAS FINANCIALLY AIDED THROUGH A FEDERAL GRANT FROM THE DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT, UNDER THE URBAN PLANNING ASSISTANCE PROGRAM AUTHORIZED BY SECTION 701 OF THE HOUSING ACT OF 1954, AS AMENDED

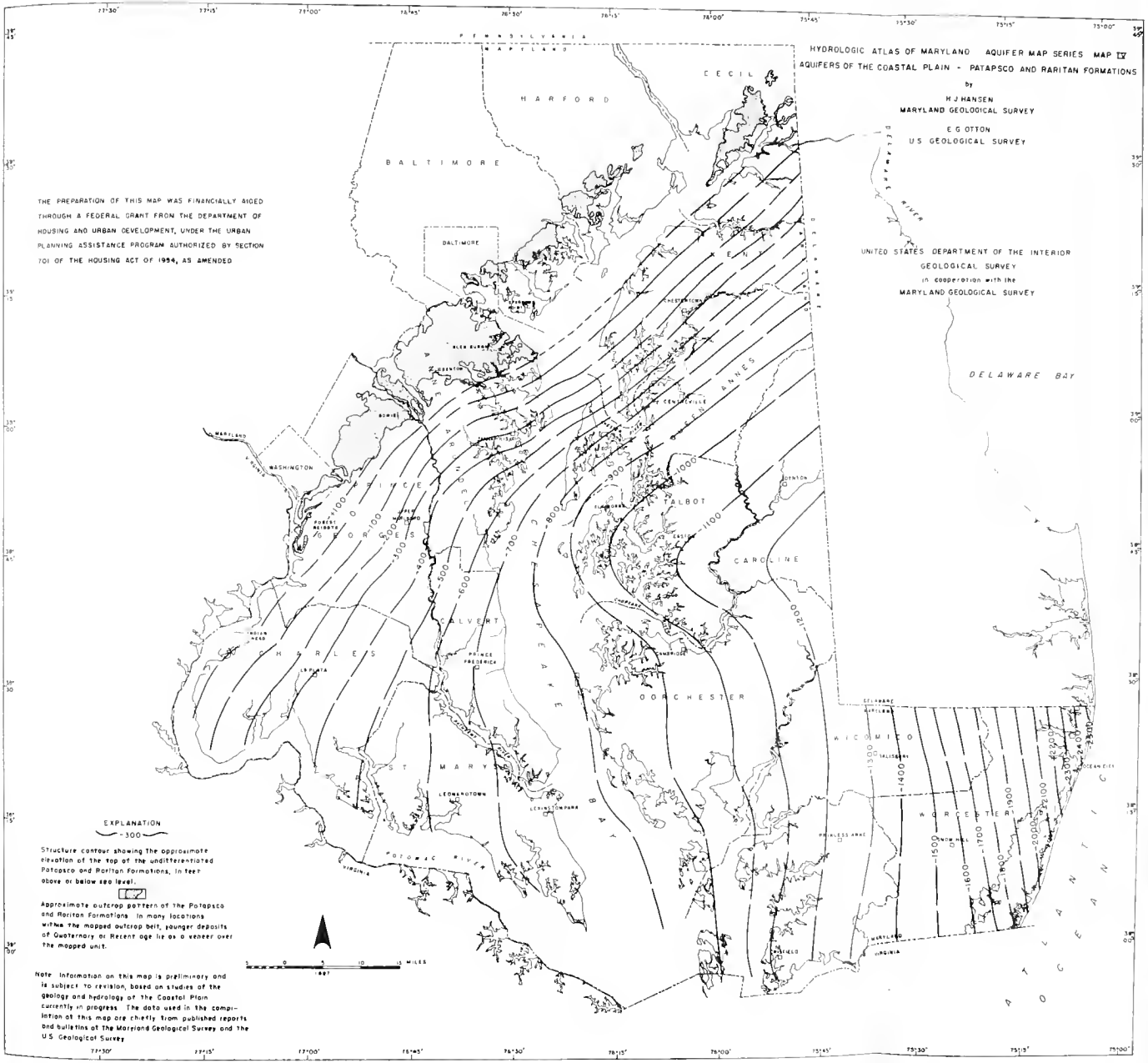
EXPLANATION

-300

Structure contour showing the approximate elevation of the top of the undifferentiated Patapsco and Raritan Formations, in feet above or below sea level.

Approximate outcrop pattern of the Patapsco and Raritan Formations. In many locations within the mapped outcrop belt, younger deposits of Quaternary or Recent age lie as a veneer over the mapped unit.

Note. Information on this map is preliminary and is subject to revision, based on studies of the geology and hydrology of the Coastal Plain currently in progress. The data used in the compilation of this map are chiefly from published reports and bulletins of the Maryland Geological Survey and the U.S. Geological Survey.

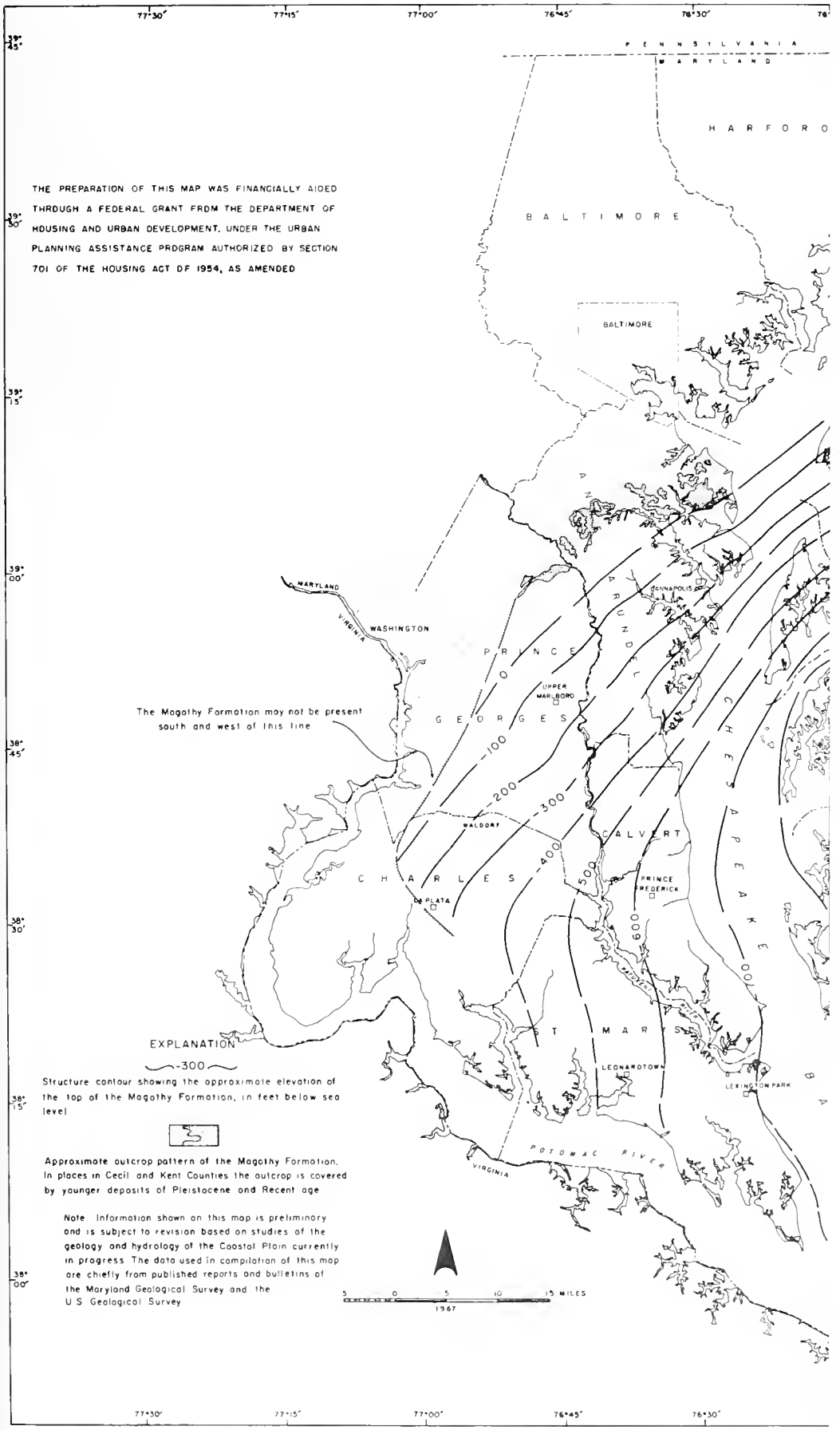

HYDROLOGIC ATLAS OF MARYLAND AQUIFER MAP SERIES MAP IV
AQUIFERS OF THE COASTAL PLAIN - PATAPSCO AND RARITAN FORMATIONS
by
H J HANSEN
MARYLAND GEOLOGICAL SURVEY
E G OTTON
U S GEOLOGICAL SURVEY
UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
in cooperation with the
MARYLAND GEOLOGICAL SURVEY
THE PREPARATION OF THIS MAP WAS FINANCIALLY AIDED THROUGH A FEDERAL GRANT FROM THE DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT, UNDER THE URBAN PLANNING ASSISTANCE PROGRAM AUTHORIZED BY SECTION 701 OF THE HOUSING ACT OF 1954, AS AMENDED
EXPLANATION
-300-
Structure contour showing the approximate elevation of the top of the undifferentiated Patapsco and Raritan Formations, in feet above or below sea level.
Approximate outcrop pattern of the Patapsco and Raritan Formations. In many locations within the mapped outcrop belt, younger deposits of Quaternary or Recent age lie as a veneer over the mapped unit.
Note: Information on this map is preliminary and is subject to revision, based on studies of the geology and hydrology of the Coastal Plain currently in progress. The data used in the compilation of this map are chiefly from published reports and bulletins of the Maryland Geological Survey and the U.S. Geological Survey
5 0 5 10 15 MILES
1:487
PENNSYLVANIA
MARYLAND
CECIL
HARFORD
BALTIMORE
BALTIMORE
KENT
QUEEN ANNES
TALBOT
CAROLINE
DORCHESTER
WICOMICO
WORCESTER
SOMERSET
CALVERT
CHARLES
ST MARY
ANNE ARUNDEL
PRINCE GEORGES
MONTGOMERY
FREDERICK
WASHINGTON
ALLEGANY
GARRETT
CHESAPEAKE BAY
DELAWARE BAY
ATLANTIC OCEAN
POTOMAC RIVER
DELAWARE RIVER
-100-
-200-
-300-
-400-
-500-
-600-
-700-
-800-
-900-
-1000-
-1100-
-1200-
-1300-
-1400-
-1500-
-1600-
-1700-
-1800-
-1900-
-2000-
-2100-
-2200-
-2300-
-2400-
-2500-

MAGOTHY FORMATION

The Magothy Formation is one of the most extensive water-bearing formations (aquifers) in the Coastal Plain of Maryland. The Magothy consists chiefly of beds of sand and gravel with interbedded layers of clay and silty clay. The sands commonly contain fossil wood and, in places, marine shells. The formation ranges from a few feet thick near La Plata to as much as 160 feet thick northeast of Upper Marlboro.

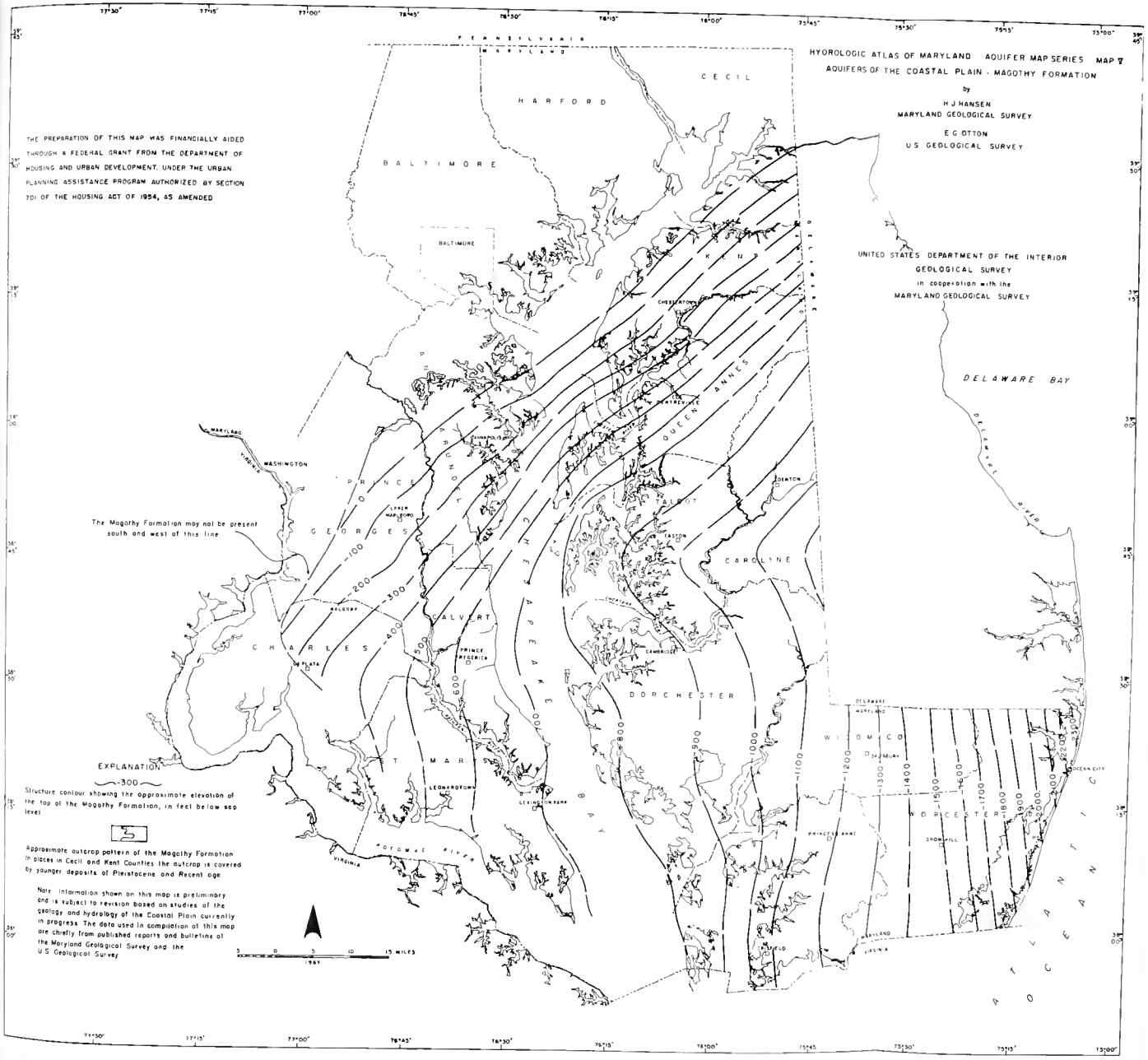
The Magothy supplies water to wells at or near several towns in the State; among these are Upper Marlboro, Waldorf, Easton, Cambridge, and Crisfield. Yields of wells range from a few to several hundreds of gallons a minute. The water is commonly usable for most purposes but locally, as in the Annapolis area, may be acidic and high in iron content.

The aquifer is believed capable of substantial additional development in many areas where it has been tapped by only a few wells or where adequate water supplies have heretofore been obtained from other shallower aquifers.



THE PREPARATION OF THIS MAP WAS FINANCIALLY AIDED THROUGH A FEDERAL GRANT FROM THE DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT, UNDER THE URBAN PLANNING ASSISTANCE PROGRAM AUTHORIZED BY SECTION 701 OF THE HOUSING ACT OF 1954, AS AMENDED

Note Information shown on this map is preliminary and is subject to revision based on studies of the geology and hydrology of the Coastal Plain currently in progress The data used in compilation of this map are chiefly from published reports and bulletins of the Maryland Geological Survey and the U S Geological Survey

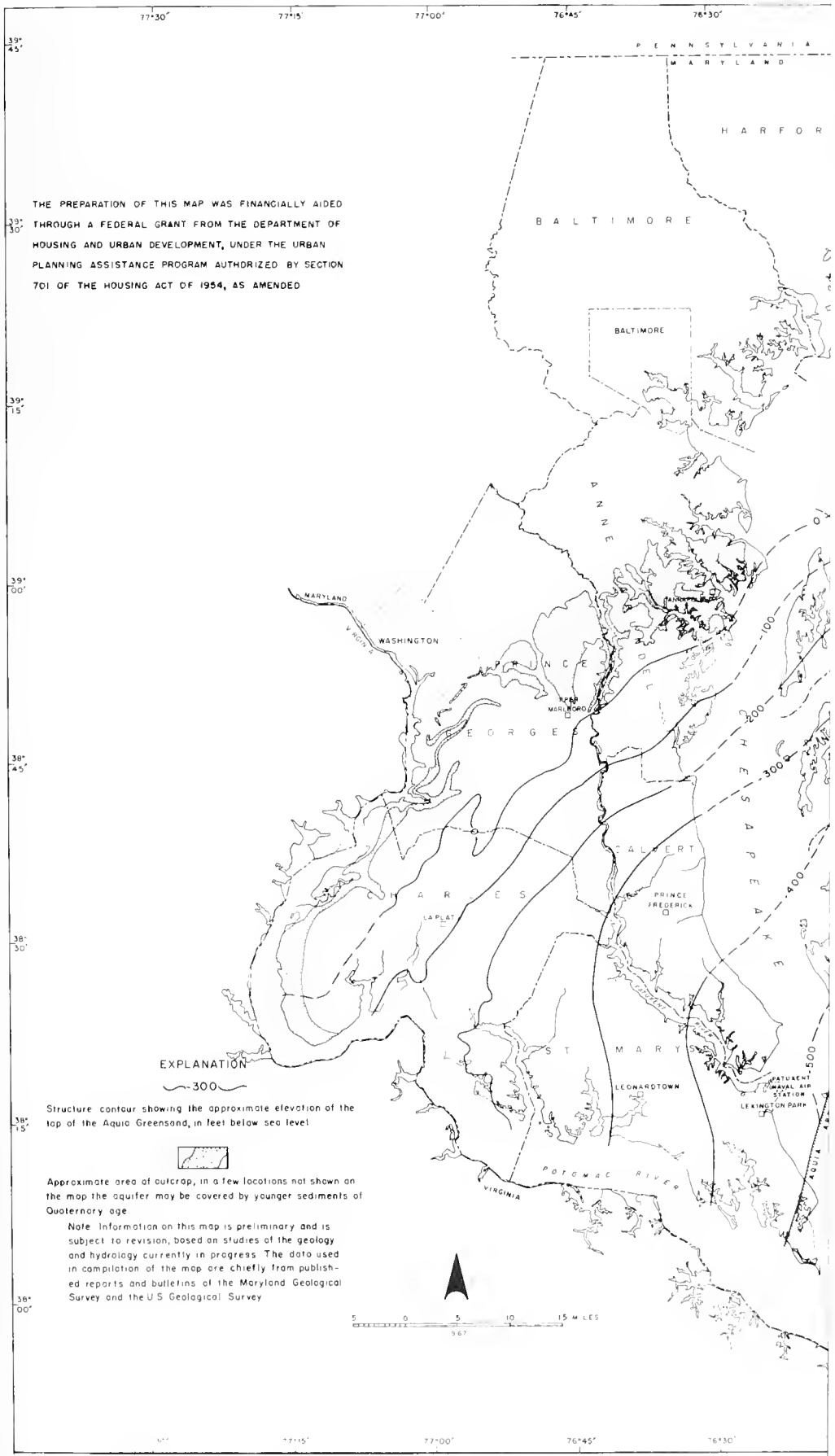

HYDROLOGIC ATLAS OF MARYLAND AQUIFER MAP SERIES MAP V
AQUIFERS OF THE COASTAL PLAIN - MAGOTHY FORMATION
by
H J HANSEN
MARYLAND GEOLOGICAL SURVEY
E G OTTON
U S GEOLOGICAL SURVEY
UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
in cooperation with the
MARYLAND GEOLOGICAL SURVEY
THE PREPARATION OF THIS MAP WAS FINANCIALLY AIDED THROUGH A FEDERAL GRANT FROM THE DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT, UNDER THE URBAN PLANNING ASSISTANCE PROGRAM AUTHORIZED BY SECTION 701 OF THE HOUSING ACT OF 1954, AS AMENDED
The Magothy Formation may not be present south and west of this line
EXPLANATION
-300-
Structure contour showing the approximate elevation of the top of the Magothy Formation, in feet below sea level
Approximate outcrop pattern of the Magothy Formation in places in Cecil and Kent Counties the outcrop is covered by younger deposits of Pleistocene and Recent age
Note Information shown on this map is preliminary and is subject to revision based on studies of the geology and hydrology of the Coastal Plain currently in progress The data used in compilation of this map are chiefly from published reports and bulletins of the Maryland Geological Survey and the U S Geological Survey
5 0 5 10 15 MILES
1961
PENNSYLVANIA
MARYLAND
DELAWARE
VIRGINIA
CECIL
HARFORD
BALTIMORE
BALTIMORE
KENT
QUEEN ANNES
PRINCE GEORGES
CHARLES
CALVERT
ST MARYS
TALBOT
CAROLINE
DORCHESTER
WICOMICO
WORCESTER
CHESAPEAKE BAY
DELAWARE BAY
DELAWARE RIVER
POTOMAC RIVER
ATLANTIC OCEAN
WASHINGTON
ANNAPOLIS
CHESTERTOWN
CENTREVILLE
QUEENSTOWN
EASTON
OXFORD
CAMBRIDGE
SALISBURY
OCEAN CITY
SNOW HILL
PRINCESS ANNE
CRISFIELD
LEONARDTOWN
LEXINGTON PARK
PRINCE FREDERICK
PORT TOBACCO
LA PLATA
UPPER MARLBORO
-100
-200
-300
-400
-500
-600
-700
-800
-900
-1000
-1100
-1200
-1300
-1400
-1500
-1600
-1700
-1800
-1900
-2000
-2100
-2200
-2300

AQUIA GREENSAND

The Aquia Greensand is one of the most important aquifers in the five Southern Maryland counties and in Kent, Queen Anne's, Caroline, Talbot, and Dorchester counties on the Eastern Shore. The Aquia consists of moderately glauconitic quartz sand with a few clay layers and some indurated layers in its middle and basal parts. Its thickness ranges from a few feet along the outcrop belt to as much as 231 feet in Talbot County. Wells producing from the Aquia Greensand have yields ranging from a few to 1,300 gallons per minuts (gpm). The most productive well is for irrigation use and is located in eastern Kent County. A well yielding 350 gpm was tested at the Patuxent Naval Air Station in St. Mary's County where the formation is a primary ground-water source.

The following towns use the Aquia as the major source for their municipal supply: Chestertown, Centreville, Grasonville, Queenstown, and Leonardtown. During recent years the aquifer has become an important source of water for supplemental irrigation on the Eastern Shore. The water is generally of good chemical quality and in many localities is usable with little or no treatment. However, locally treatment for iron removal may be required.

The Aquia Greensand is capable of additional development in many localities in the Coastal Plain.



THE PREPARATION OF THIS MAP WAS FINANCIALLY AIDED THROUGH A FEDERAL GRANT FROM THE DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT, UNDER THE URBAN PLANNING ASSISTANCE PROGRAM AUTHORIZED BY SECTION 701 OF THE HOUSING ACT OF 1954, AS AMENDED

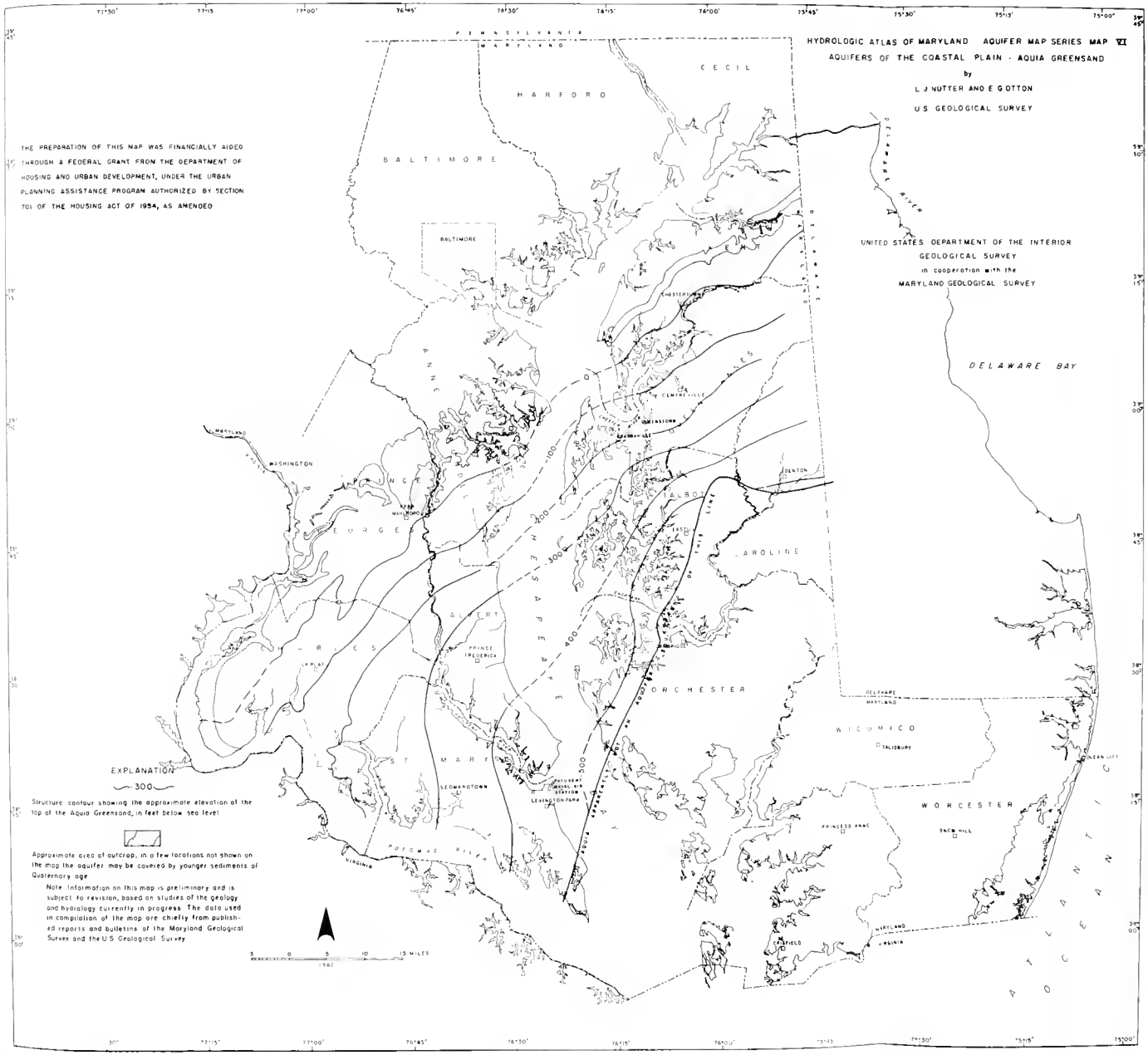
EXPLANATION

~300~

Structure contour showing the approximate elevation of the top of the Aquia Greensand, in feet below sea level

Approximate area of outcrop, in a few locations not shown on the map the aquifer may be covered by younger sediments of Quaternary age

Note Information on this map is preliminary and is subject to revision, based on studies of the geology and hydrology currently in progress The data used in compilation of the map are chiefly from published reports and bulletins of the Maryland Geological Survey and the U S Geological Survey

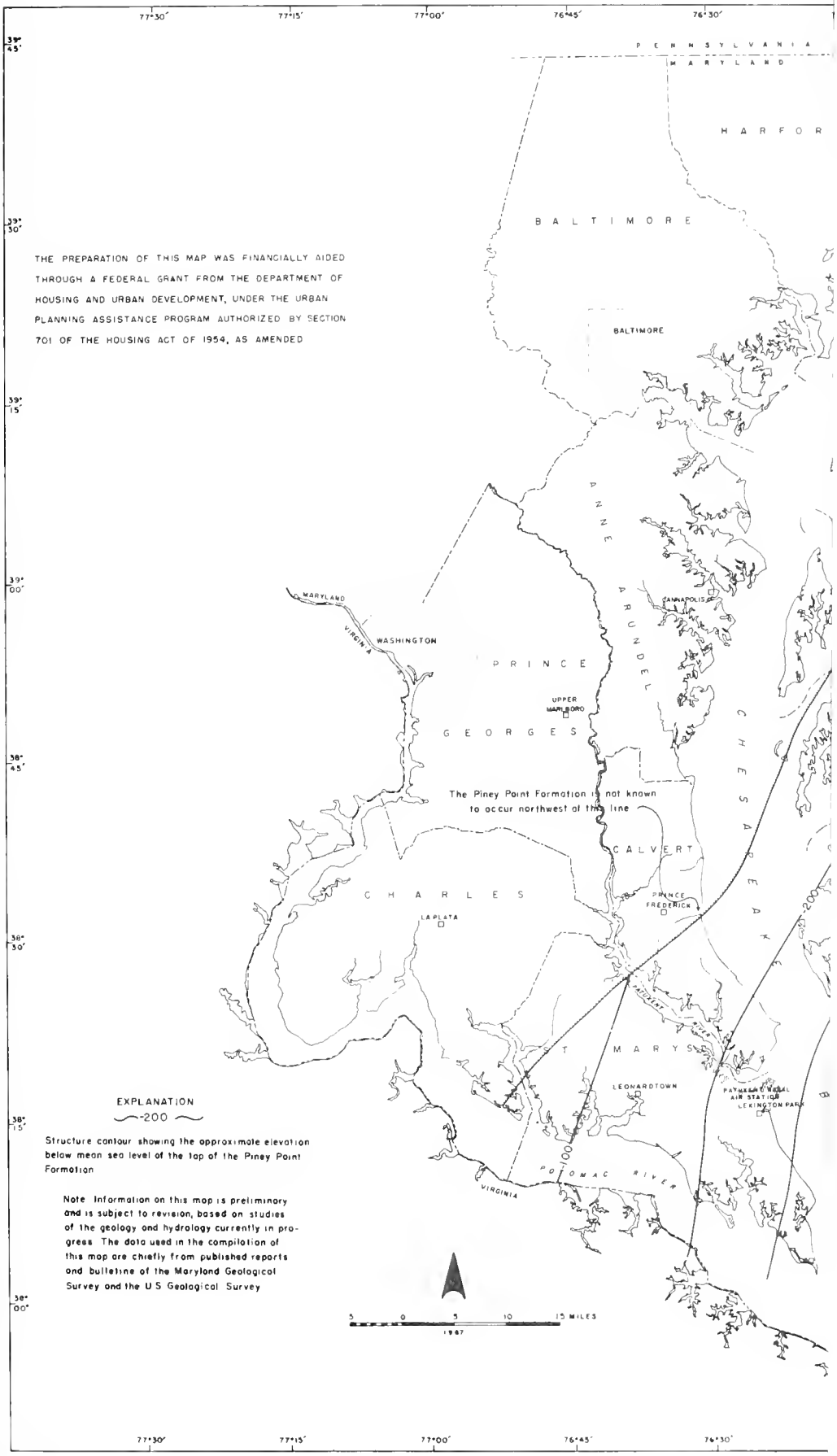

HYDROLOGIC ATLAS OF MARYLAND AQUIFER MAP SERIES MAP VI
AQUIFERS OF THE COASTAL PLAIN - AQUIA GREENSAND
by
L J NUTTER AND E G OTTON
U S GEOLOGICAL SURVEY
THE PREPARATION OF THIS MAP WAS FINANCIALLY AIDED THROUGH A FEDERAL GRANT FROM THE DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT, UNDER THE URBAN PLANNING ASSISTANCE PROGRAM AUTHORIZED BY SECTION 701 OF THE HOUSING ACT OF 1954, AS AMENDED
UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
in cooperation with the
MARYLAND GEOLOGICAL SURVEY
PENNSYLVANIA
MARYLAND
CECIL
HARFORD
BALTIMORE
BALTIMORE
CHESAPEAKE AND DELAWARE CANAL
DELAWARE BAY
WASHINGTON
MONTGOMERY
PRINCE GEORGES
ANNE ARUNDEL
CALVERT
CHARLES
ST MARYS
KENT
QUEEN ANNES
TALBOT
CAROLINE
DORCHESTER
WICOMICO
SOMERSET
WORCESTER
ATLANTIC OCEAN
EXPLANATION
300
Structure contour showing the approximate elevation of the top of the Aquia Greensand, in feet below sea level
Approximate area of outcrop, in a few locations not shown on the map the aquifer may be covered by younger sediments of Quaternary age
Note: Information on this map is preliminary and is subject to revision, based on studies of the geology and hydrology currently in progress. The data used in compilation of the map are chiefly from published reports and bulletins of the Maryland Geological Survey and the U.S. Geological Survey
5 0 5 10 15 MILES

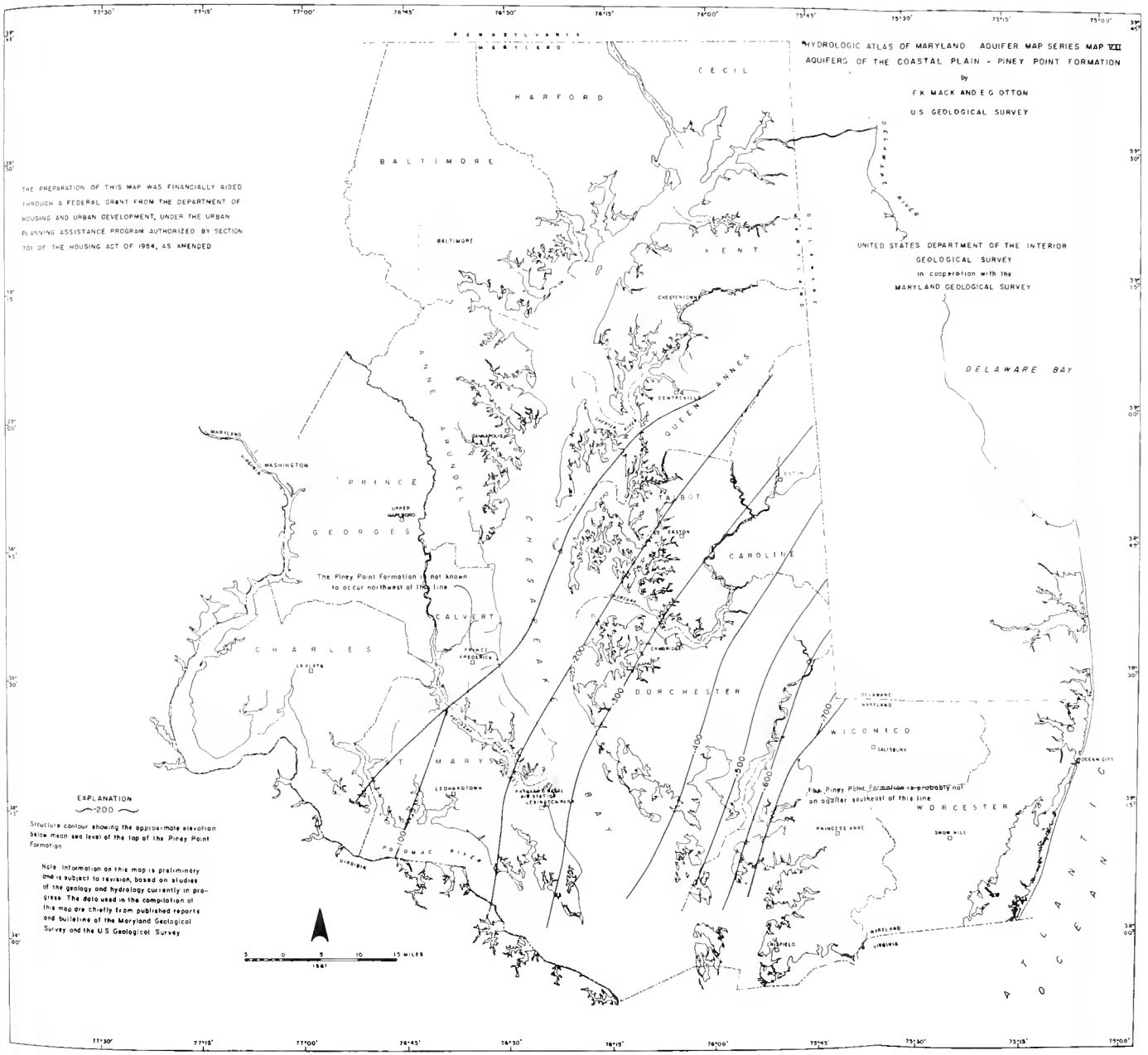
PINEY POINT FORMATION

The Piney Point Formation is a major aquifer in Calvert, St. Mary's, Dorchester, Talbot, and Caroline counties, extending southward into Virginia and northeastward into Delaware. The formation consists of glauconitic medium- to coarse-grained sand and interspersed shell beds from 10 feet to more than 100 feet thick, but generally only 50 to 60 feet thick. The Piney Point Formation has no known surface outcrop. The maximum altitude of its known occurrence is about 80 feet below sea level at a point along the lower Patuxent River. Locally the sands of the Piney Point Formation appear to be hydrologically connected with the sands of underlying Nanjemoy Formation, and therefore, the two formations may function as a single aquifer. The yields of wells range from less than 10 to about 1,200 gallons per minute (gpm). The most productive well is a part of the public-supply system of Cambridge, Maryland.

The Piney Point Formation is a source of water for the Patuxent Naval Air Station. It is also tapped by hundreds of domestic wells throughout the area. The chemical quality of the water is good and is relatively uniform. Water treatment is seldom required.

The apparent limited areal extent of this formation coupled with the limited recharge capability of the aquifer suggest that only moderate development can be expected. More precise definition of the extent and hydrologic character of the aquifer is needed.


77°30'
77°15'
77°00'
76°45'
76°30'
39°45'
39°30'
39°15'
39°00'
38°45'
38°30'
38°15'
38°00'
PENNSYLVANIA
MARYLAND
HARFOR
BALTIMORE
BALTIMORE
THE PREPARATION OF THIS MAP WAS FINANCIALLY AIDED THROUGH A FEDERAL GRANT FROM THE DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT, UNDER THE URBAN PLANNING ASSISTANCE PROGRAM AUTHORIZED BY SECTION 701 OF THE HOUSING ACT OF 1954, AS AMENDED
ANNE ARUNDEL
ANNAPOLIS
MARYLAND
VIRGINIA
WASHINGTON
PRINCE GEORGES
UPPER MARLBORO
The Piney Point Formation is not known to occur northwest of this line
CHESAPEAKE BAY
CALVERT
PRINCE FREDERICK
CHARLES
LA PLATA
-200
PATUXENT RIVER
ST MARYS
LEONARDTOWN
PATUXENT NAVAL AIR STATION LEXINGTON PARK
-100
POTOMAC RIVER
VIRGINIA
EXPLANATION
-200
Structure contour showing the approximate elevation below mean sea level of the top of the Piney Point Formation
Note Information on this map is preliminary and is subject to revision, based on studies of the geology and hydrology currently in progress The data used in the compilation of this map are chiefly from published reports and bulletins of the Maryland Geological Survey and the U S Geological Survey
5 0 5 10 15 MILES
1967

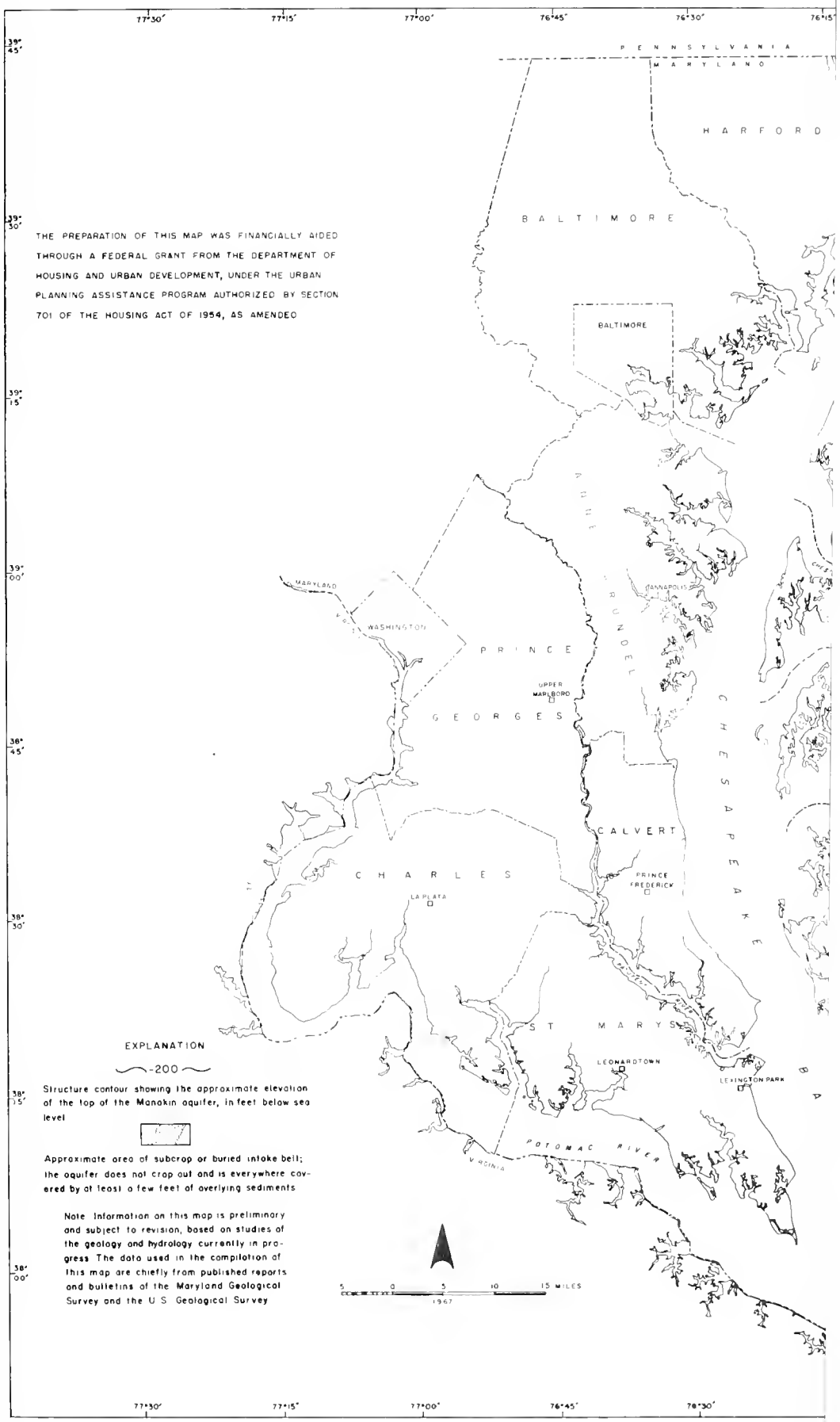

HYDROLOGIC ATLAS OF MARYLAND AQUIFER MAP SERIES MAP VII
AQUIFERS OF THE COASTAL PLAIN - PINEY POINT FORMATION
by
F.K. MACK AND E.G. OTTON
U.S. GEOLOGICAL SURVEY
THE PREPARATION OF THIS MAP WAS FINANCIALLY AIDED THROUGH A FEDERAL GRANT FROM THE DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT, UNDER THE URBAN PLANNING ASSISTANCE PROGRAM AUTHORIZED BY SECTION 701 OF THE HOUSING ACT OF 1954, AS AMENDED
UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
in cooperation with the
MARYLAND GEOLOGICAL SURVEY
PENNSYLVANIA
MARYLAND
DELAWARE
VIRGINIA
CECIL
HARFORD
BALTIMORE
BALTIMORE
KENT
QUEEN ANNES
TALBOT
CAROLINE
DORCHESTER
WICOMICO
WORCESTER
ANNE ARUNDEL
PRINCE GEORGES
CALVERT
CHARLES
ST MARYS
WASHINGTON
UPPER MARLBORO
LEONARDTOWN
LEXINGTON PARK
PATUXENT NAVAL AIR STATION
CHESTERTOWN
CENTREVILLE
EASTON
CAMBRIDGE
SALISBURY
OCEAN CITY
PRINCESS ANNE
SNOW HILL
CRISFIELD
DELAWARE BAY
CHESAPEAKE BAY
POTOMAC RIVER
DELAWARE RIVER
ATLANTIC OCEAN
The Piney Point Formation is not known to occur northeast of this line
The Piney Point Formation is probably not an aquifer southeast of this line
EXPLANATION
-200-
Structure contour showing the approximate elevation below mean sea level of the top of the Piney Point Formation
Note: Information on this map is preliminary and is subject to revision, based on studies of the geology and hydrology currently in progress. The data used in the compilation of this map are chiefly from published reports and bulletins of the Maryland Geological Survey and the U.S. Geological Survey
5 0 5 10 15 MILES
1:500
77°30' 77°15' 77°00' 76°45' 76°30' 76°15' 76°00' 75°45' 75°30' 75°15' 75°00'
39° 45' 39° 30' 39° 15' 39° 00' 38° 45' 38° 30' 38° 15' 38° 00'

MANOKIN AQUIFER

The Manokin aquifer, a part of the Yorktown Formation, is an important aquifer in Somerset, Wicomico, and Worcester counties. It consists of gray, medium- to fine-grained sand and commonly ranges in thickness from about 90 to 200 feet. In many places the sand is overlain and underlain by silt, and clay, and very fine sand which causes artesian or confining conditions and produces flowing wells in some localities. The yields of the most productive wells tapping the Manokin aquifer range from less than 100 to over 1,000 gallons per minute (gpm), although most public-supply well yields are in the 300 to 400 gpm range.

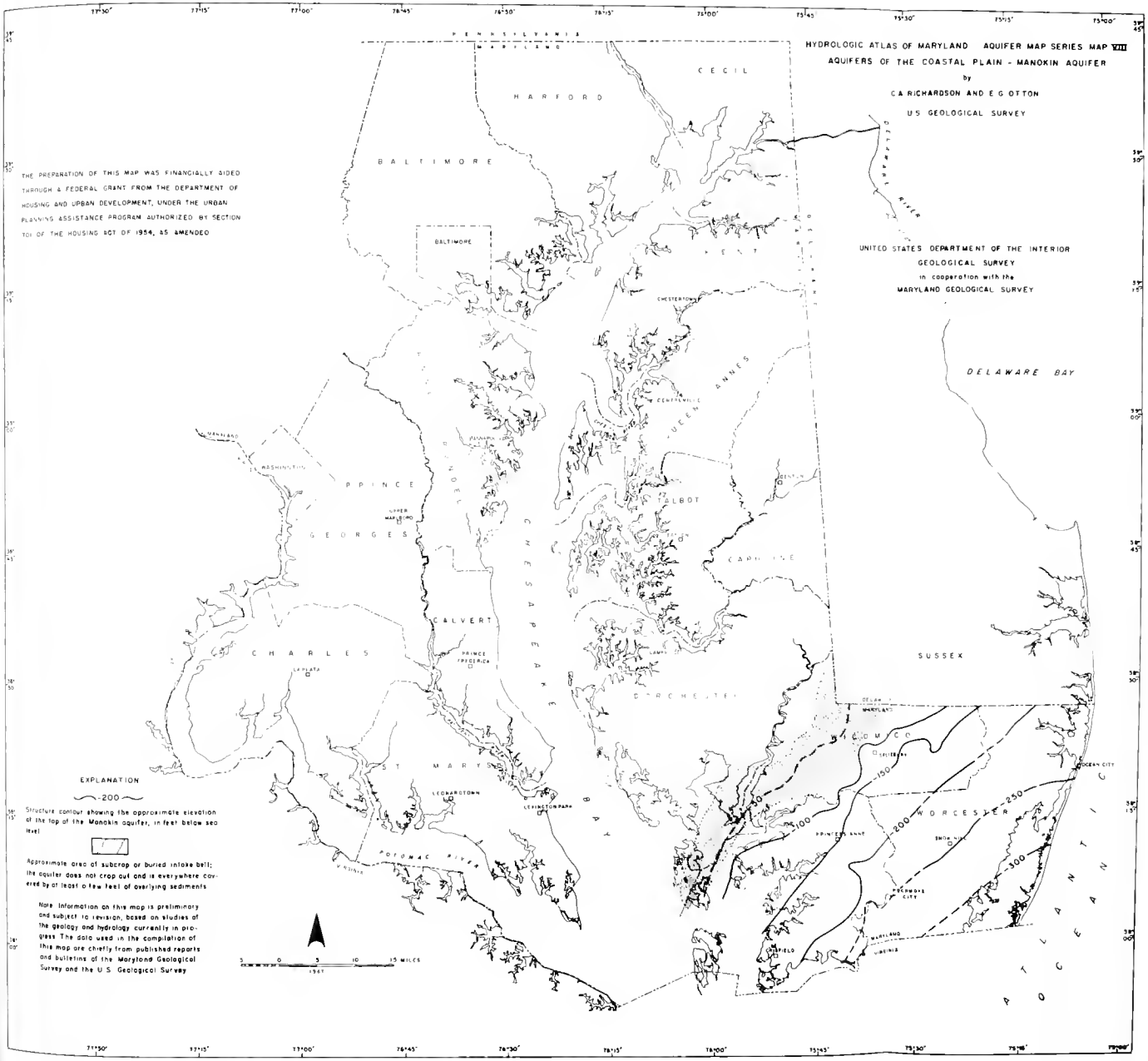
The Manokin aquifer is a source of water for municipal and/or industrial supplies at Ocean City, Snow Hill, Princess Anne, and Salisbury. It is also used as a ground-water source in the southeastern part of Sussex County, Delaware. The chemical character of the water varies widely within the area. In places, the water may be mildly acidic and/or high in iron content. In other places, such as Pocomoke City and Crisfield, the water contains more than 200 parts per million of chloride.

The Manokin is capable of additional development in some localities, but in others it is not likely to be used because of the undesirable chemical character of the water.



THE PREPARATION OF THIS MAP WAS FINANCIALLY AIDED THROUGH A FEDERAL GRANT FROM THE DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT, UNDER THE URBAN PLANNING ASSISTANCE PROGRAM AUTHORIZED BY SECTION 701 OF THE HOUSING ACT OF 1954, AS AMENDED

Note Information on this map is preliminary and subject to revision, based on studies of the geology and hydrology currently in progress The data used in the compilation of this map are chiefly from published reports and bulletins of the Maryland Geological Survey and the U S Geological Survey

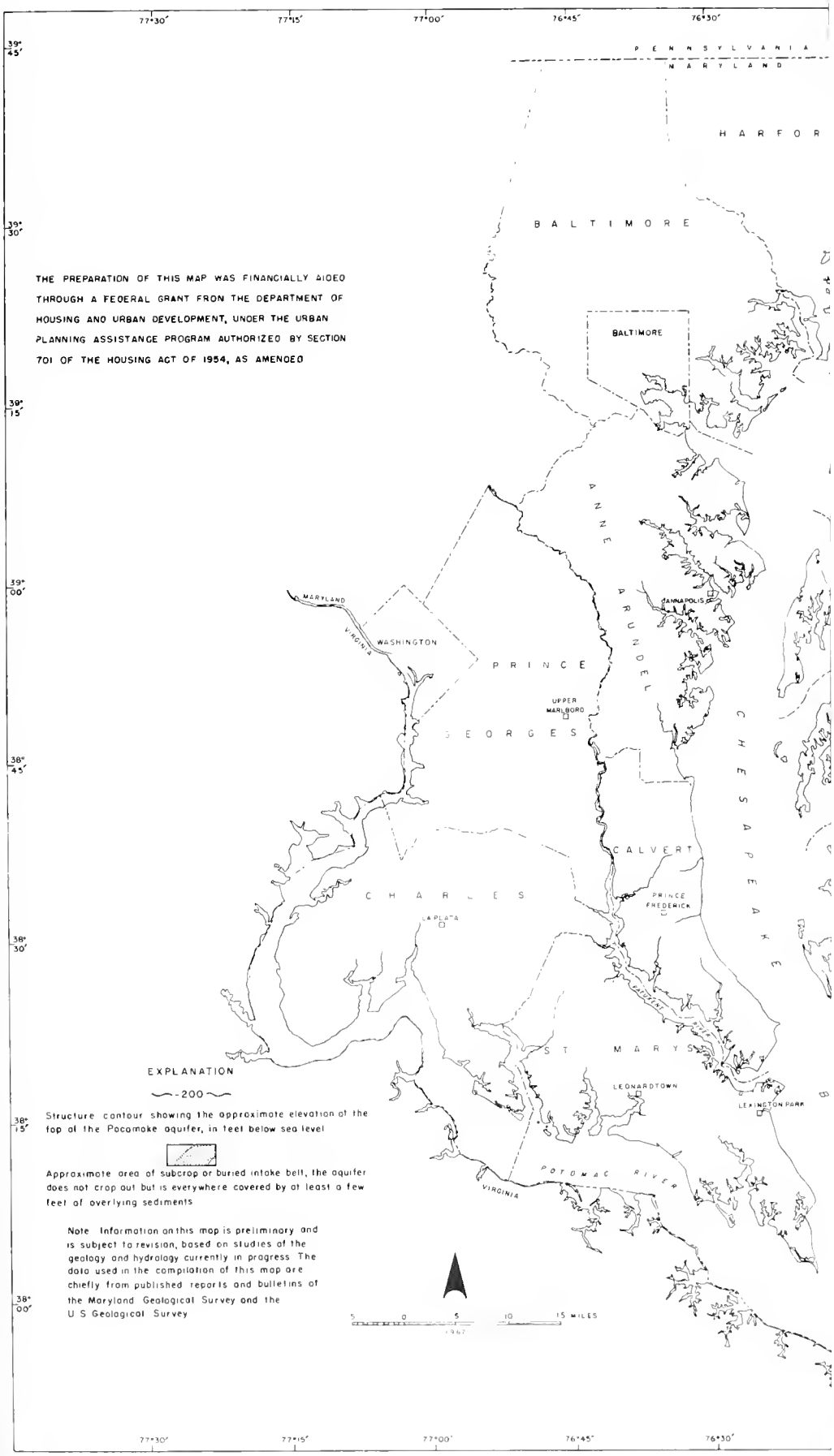

HYDROLOGIC ATLAS OF MARYLAND AQUIFER MAP SERIES MAP VIII
AQUIFERS OF THE COASTAL PLAIN - MANOKIN AQUIFER
by
C A RICHARDSON AND E G OTTON
U S GEOLOGICAL SURVEY
THE PREPARATION OF THIS MAP WAS FINANCIALLY AIDED THROUGH A FEDERAL GRANT FROM THE DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT, UNDER THE URBAN PLANNING ASSISTANCE PROGRAM AUTHORIZED BY SECTION 701 OF THE HOUSING ACT OF 1954, AS AMENDED
UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
in cooperation with the
MARYLAND GEOLOGICAL SURVEY
PENNSYLVANIA
MARYLAND
CECIL
HARFORD
BALTIMORE
BALTIMORE
CHESTERTOWN
CENTREVILLE
QUEEN ANNES
KENT
TALBOT
CAROLINE
DORCHESTER
SUSSEX
DELAWARE BAY
DELAWARE RIVER
CHESAPEAKE BAY
PRINCE GEORGES
CALVERT
CHARLES
ST MARYS
WICOMICO
WORCESTER
SALISBURY
OCEAN CITY
PRINCESS ANNE
SNOW HILL
POCOMOKE CITY
CRISFIELD
LA PLATA
PRINCE FREDERICK
LEONARDTOWN
LEXINGTON PARK
UPPER MARLBORO
WASHINGTON
POTOMAC RIVER
ATLANTIC
EXPLANATION
-200-
Structure contour showing the approximate elevation of the top of the Manokin aquifer, in feet below sea level
Approximate area of subcrop or buried intake belt; the aquifer does not crop out and is everywhere covered by at least a few feet of overlying sediments
Note Information on this map is preliminary and subject to revision, based on studies of the geology and hydrology currently in progress The data used in the compilation of this map are chiefly from published reports and bulletins of the Maryland Geological Survey and the U S Geological Survey
50
100
150
200
250
300
5 0 5 10 15 MILES
1967

POCOMOKE AQUIFER

The Pocomoke aquifer, a part of the Yorktown Formation, is a major source of groundwater in Somerset and Worcester counties. It consists of gray, medium- to fine-grained sand with some gravel and thin lenses of clay. In many localities it is overlain and underlain by silt and clay, producing artesian conditions. Southeast of its intake belt the aquifer commonly ranges in thickness from 85 to about 145 feet. The yields of high capacity wells range from about 100 to about 660 gallons per minute (gpm). Generally, wells yielding more than 500 gpm appear to be exceptional.

The Pocomoke aquifer furnishes water for municipal and/or industrial supplies at Pocomoke City, Ocean City, and Crisfield. Locally, iron content of the water is high. The water is moderately soft to moderately hard (hardness range of 60 to 120 parts per million). In places treatment for iron removal may be required for many uses of the water.

The Pocomoke is capable of furnishing large additional supplies of groundwater throughout parts of Somerset and Wicomico counties and nearly all of Worcester County, but its potential may be restricted in some localities by the hazard of salt-water intrusion.



THE PREPARATION OF THIS MAP WAS FINANCIALLY AIDED THROUGH A FEDERAL GRANT FROM THE DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT, UNDER THE URBAN PLANNING ASSISTANCE PROGRAM AUTHORIZED BY SECTION 701 OF THE HOUSING ACT OF 1954, AS AMENDED

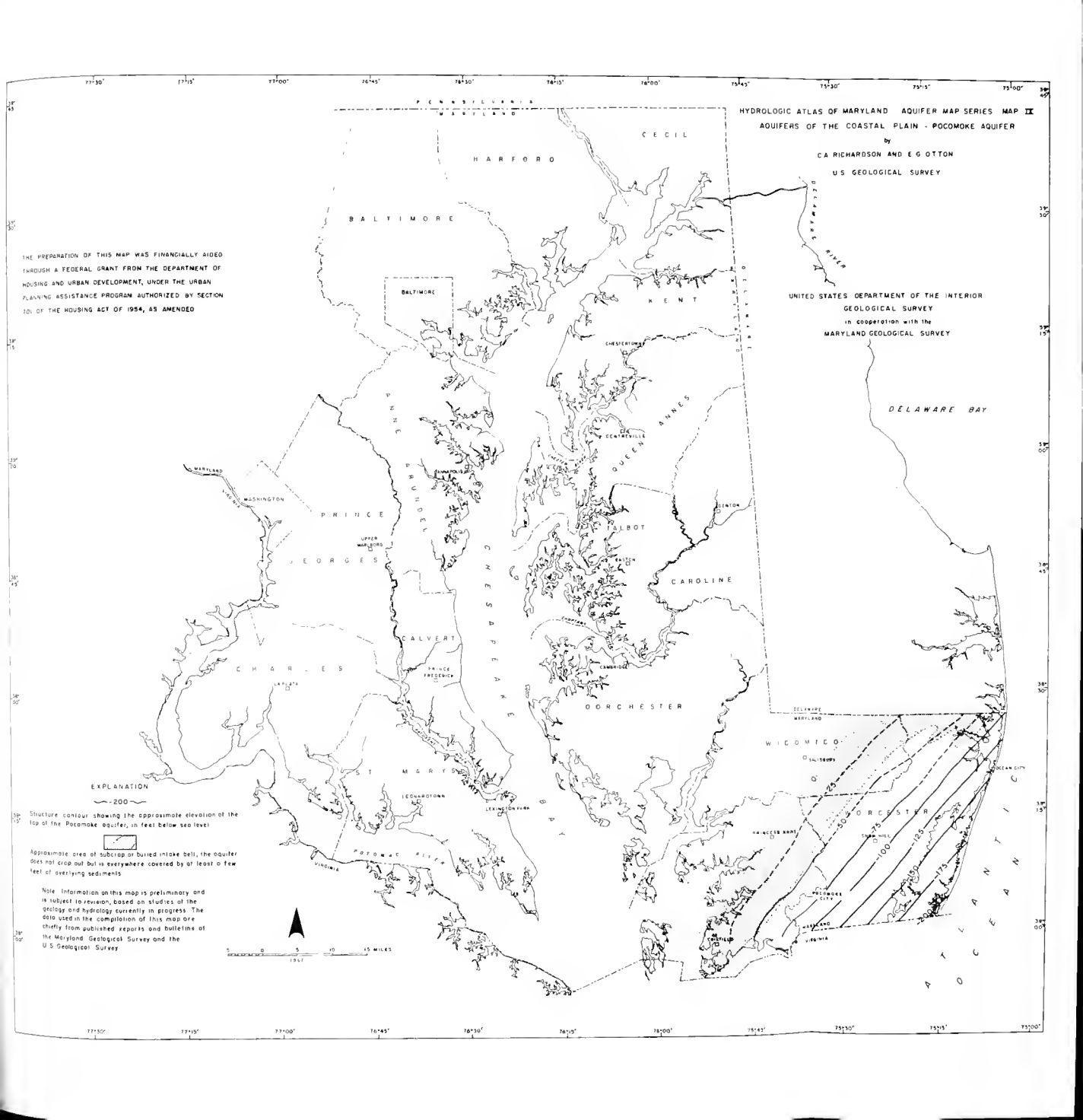
EXPLANATION

-200-

Structure contour showing the approximate elevation of the top of the Pocomoke aquifer, in feet below sea level

Approximate area of subcrop or buried intake belt, the aquifer does not crop out but is everywhere covered by at least a few feet of overlying sediments

Note Information on this map is preliminary and is subject to revision, based on studies of the geology and hydrology currently in progress The data used in the compilation of this map are chiefly from published reports and bulletins of the Maryland Geological Survey and the U S Geological Survey


HYDROLOGIC ATLAS OF MARYLAND AQUIFER MAP SERIES MAP II
AQUIFERS OF THE COASTAL PLAIN - POCOMOKE AQUIFER
by
C A RICHARDSON AND E G OTTON
U S GEOLOGICAL SURVEY
THE PREPARATION OF THIS MAP WAS FINANCIALLY AIDED THROUGH A FEDERAL GRANT FROM THE DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT, UNDER THE URBAN PLANNING ASSISTANCE PROGRAM AUTHORIZED BY SECTION 701 OF THE HOUSING ACT OF 1954, AS AMENDED
UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
in cooperation with the
MARYLAND GEOLOGICAL SURVEY
PENNSYLVANIA
MARYLAND
CECIL
HARFORD
BALTIMORE
BALTIMORE
KENT
DELAWARE
DELAWARE RIVER
DELAWARE BAY
QUEEN ANNES
TALBOT
CAROLINE
DORCHESTER
WICOMICO
SOMERSET
WORCESTER
ANNE ARUNDEL
PRINCE GEORGES
CALVERT
CHARLES
ST MARYS
CHESAPEAKE BAY
POTOMAC RIVER
VIRGINIA
ATLANTIC OCEAN
OCEAN CITY
EXPLANATION
-200
Structure contour showing the approximate elevation of the top of the Pocomoke aquifer, in feet below sea level
Approximate area of subcrop or buried intake bell, the aquifer does not crop out but is everywhere covered by at least a few feet of overlying sediments
Note Information on this map is preliminary and is subject to revision, based on studies of the geology and hydrology currently in progress The data used in the compilation of this map are chiefly from published reports and bulletins of the Maryland Geological Survey and the U S Geological Survey
5 0 5 10 15 MILES
1967

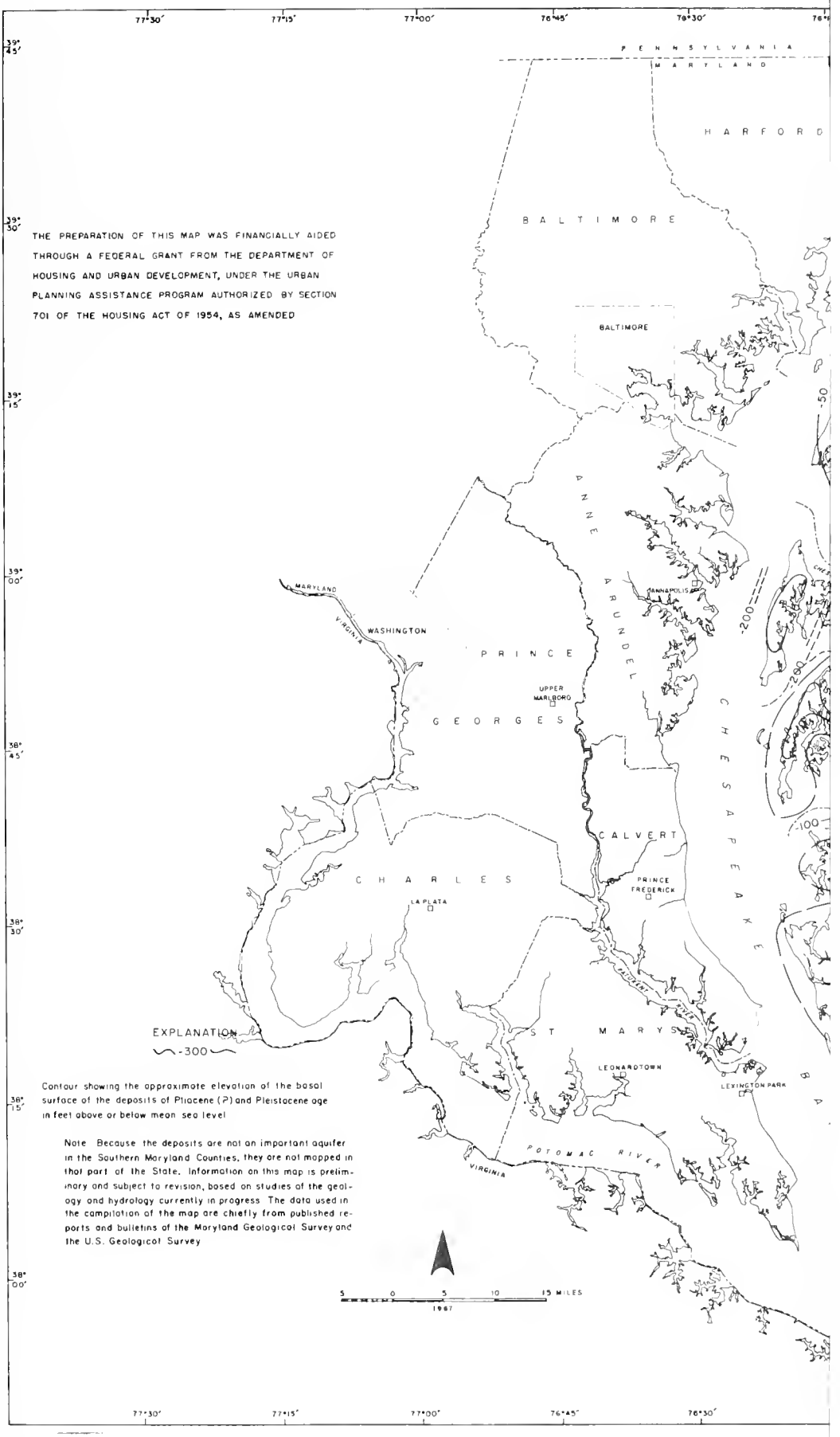
DEPOSITS OF PLIOCENE (?) AND PLEISTOCENE AGE

The deposits of Pliocene (?) and Pleistocene age comprise the major aquifer throughout most of the Eastern Shore counties. They are present at present in all of the Eastern Shore counties. The deposits are present at some localities in the Southern Maryland counties, but there they are not an important aquifer. They consist of yellowish to tan and white sand and gravel with some layers of silty clay and clay ranging from a few feet to about 220 feet thick in an area north of Salisbury. Water-table conditions generally prevail throughout the area of their occurrence. The yields of wells tapping the more permeable sand and gravel on the Eastern Shore range as high as 4,000 gallons per minute (gpm), and it is probable that even more productive wells can be constructed in the more favorable localities.

The Pleistocene deposits are the source of water supply for the towns of Salisbury, Berlin, Mardela Springs, Barclay, and for other smaller communities. At Salisbury, supplies of several millions of gallons a day have been developed from these deposits by means of large-diameter wells, 40 to 60 feet deep. Generally, the water is of good chemical quality but locally treatment for iron removal and de-acidification is necessary.

In Queen Anne's, Dorchester, and Wicomico counties individual irrigation wells are known to yield more than one million gallons a day (mgd), but as this use is a seasonal use and is dependent on climatic conditions, it represents no major draft on the aquifer.

The quantity of water available from the Pleistocene deposits is estimated to be many times greater than the current (1966) rates of pumpage from them. These deposits are potentially the most productive aquifer in Maryland and capable of extensive development.



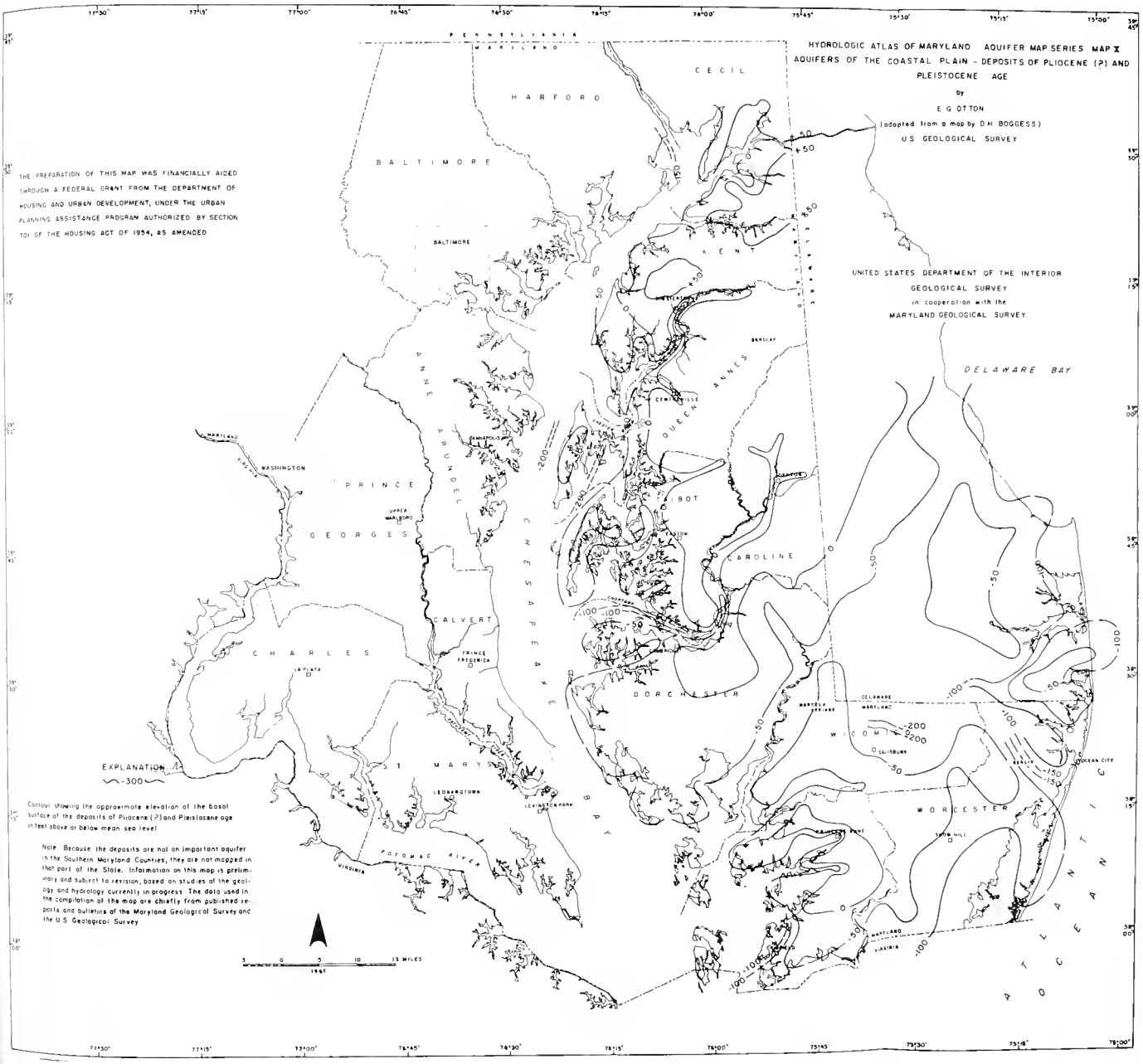
THE PREPARATION OF THIS MAP WAS FINANCIALLY AIDED THROUGH A FEDERAL GRANT FROM THE DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT, UNDER THE URBAN PLANNING ASSISTANCE PROGRAM AUTHORIZED BY SECTION 701 OF THE HOUSING ACT OF 1954, AS AMENDED

EXPLANATION

-300

Contour showing the approximate elevation of the basal surface of the deposits of Pliocene (?) and Pleistocene age in feet above or below mean sea level

Note Because the deposits are not an important aquifer in the Southern Maryland Counties, they are not mapped in that part of the State. Information on this map is preliminary and subject to revision, based on studies of the geology and hydrology currently in progress The data used in the compilation of the map are chiefly from published reports and bulletins of the Maryland Geological Survey and the U.S. Geological Survey


HYDROLOGIC ATLAS OF MARYLAND AQUIFER MAP SERIES MAP X
AQUIFERS OF THE COASTAL PLAIN - DEPOSITS OF PLIOCENE (?) AND PLEISTOCENE AGE
by
E G OTTON
(adapted from a map by D H BOGGESS)
U S GEOLOGICAL SURVEY
THE PREPARATION OF THIS MAP WAS FINANCIALLY AIDED THROUGH A FEDERAL GRANT FROM THE DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT, UNDER THE URBAN PLANNING ASSISTANCE PROGRAM AUTHORIZED BY SECTION 701 OF THE HOUSING ACT OF 1954, AS AMENDED
UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
in cooperation with the
MARYLAND GEOLOGICAL SURVEY
PENNSYLVANIA
MARYLAND
CECIL
HARFORD
BALTIMORE
BALTIMORE
KENT
QUEEN ANNES
TALBOT
CAROLINE
DORCHESTER
WICOMICO
WORCESTER
ANNE ARUNDEL
PRINCE GEORGES
CALVERT
CHARLES
ST MARYS
DELAWARE BAY
CHESAPEAKE BAY
POTOMAC RIVER
ATLANTIC OCEAN
WASHINGTON
ANNAPOLIS
SALISBURY
OCEAN CITY
EXPLANATION
-300
Contour showing the approximate elevation of the basal surface of the deposits of Pliocene (?) and Pleistocene age in feet above or below mean sea level
Note Because the deposits are not an important aquifer in the Southern Maryland Counties, they are not mapped in that part of the State. Information on this map is preliminary and subject to revision, based on studies of the geology and hydrology currently in progress The data used in the compilation of the map are chiefly from published reports and bulletins of the Maryland Geological Survey and the U S Geological Survey
5 0 5 10 15 MILES
1961

GROUND-WATER AQUIFERS

OF MARYLAND

Selected References

Bennett, R. R., and Meyer, R. R., 1952, Geology and ground-water resources of the Baltimore area: Maryland Dept. Geology, Mines and Water Resources Bull. 4.

Boggess, D. H., and Heidel, S. G., 1968, Water resources of the Salisbury area, Maryland: Maryland Geol. Survey Rept. Invest. No. 3.

Brookhart, J. W., 1949, The ground-water resources, in The water resources of Anne Arundel County: Maryland Dept. Geology, Mines and Water Resources Bull. 5, p. 28-143.

Clark, W. B., Mathews, E. B., and Berry, E. W., 1918, The surface and underground water resources of Maryland, including Delaware and the District of Columbia: Maryland Geol. Survey, v. X, pt. 2, p. 169-549.

Dingman, R. J., and Ferguson, H. F., 1956, The ground-water resources of the Piedmont part, in The water resources of Baltimore and Harford Counties: Maryland Dept. Geology, Mines and Water Resources Bull. 17, p. 1-128.

Dingman, R. J., and Meyer, Gerald, 1954, The ground-water resources, in The water resources of Howard and Montgomery Counties: Maryland Dept. Geology, Mines and Water Resources Bull. 14, p. 1-139.

Ferguson, H. F., 1953, The ground-water resources, in The water resources of St. Marys County: Maryland Dept. Geology, Mines and Water Resources Bull. 11, p. 16-189.

Hansen, H. J., 1967, Hydrologic data from the Janes Island State Park Test Well (1,514 feet) Somerset County, Maryland: Maryland Geol. Survey Basic Data Rept. No. 3.

_____, 1968, Geophysical log cross-section network of the Cretaceous sediments of southern Maryland: Maryland Geol. Survey Rept. Invest. No. 7.

Laughlin, C. P., 1966, Records of wells and springs in Baltimore County, Maryland: Maryland Geol. Survey Basic Data Rept. No. 1.

Mack, F. K., 1962, Ground-water supplies for industrial and urban development in Anne Arundel County: Maryland Dept. Geology, Mines and Water Resources Bull. 26.

_____, 1968, Ground water in Prince Georges County: Maryland Geol. Survey Bull. 29.

Meyer, Gerald, 1952, Ground-water resources, in Geology and water resources of Prince Georges County: Maryland Dept. Geology, Mines and Water Resources Bull. 10, p. 82-254.

_____, 1958, The ground-water resources, in The water resources of Carroll and Frederick Counties: Maryland Dept. Geology, Mines and Water Resources Bull. 22, p. 1-228.

Otton, E. G., 1955, Ground-water resources of the southern Maryland Coastal Plain: Maryland Dept. Geology, Mines and Water Resources Bull. 15.

Overbeck, R. M., 1948, Ground-water resources, in The physical features of Charles County: Maryland Dept. Geology, Mines and Water Resources, p. 138-184.

_____, 1951, Ground-water resources, in The water resources of Calvert County: Maryland Dept. Geology, Mines and Water Resources Bull. 8, p. 4-95.

_____, 1954, Ground-water resources, in Geology and water resources of Garrett County: Maryland Dept. Geology, Mines and Water Resources Bull. 13, p. 117-254.

Overbeck, R. M., and Slaughter, T. H., 1958, The ground-water resources, in The water resources of Cecil, Kent, and Queen Annes Counties: Maryland Dept. Geology, Mines and Water Resources Bull. 21, p. 1-382.

Rasmussen, W. C., and Slaughter, T. H., 1955, The ground-water resources, in The water resources of Somerset, Wicomico, and Worcester Counties: Maryland Dept. Geology, Mines and Water Resources Bull. 16, p. 1-170.

_____, 1957, The ground-water resources, in The water resources of Caroline, Dorchester, and Talbot Counties: Maryland Dept. Geology, Mines and Water Resources Bull. 18, p. 1-371.

Richardson, C. A., 1962, Chemical character of the water, in Ground-water supplies for industrial and urban development in Anne Arundel County: Maryland Dept. Geology, Mines and Water Resources Bull. 26, p. 75-81.

Slaughter, T. H., 1962, The ground-water resources, in The water resources of Allegany and Washington Counties: Maryland Dept. Geology, Mines and Water Resources Bull. 24, p. 1-243.

Slaughter, T. H., and Laughlin, C. P., 1966, Records of wells and springs, chemical analyses, and selected well logs in Charles County, Maryland: Maryland Geol. Survey Basic Data Rept. No. 2.

Slaughter, T. H., and Otton, E. G., 1968, Availability of ground water in Charles County, Maryland: Maryland Geol. Survey Bull. No. 30.

Thomas, J. D., and Heidel, S. G., 1969, Chemical and physical character of municipal water supplies in Maryland: Maryland Geol. Survey Rept. Invest. No. 9.

Note: The Maryland Department of Geology, Mines, and Water Resources was renamed Maryland Geological Survey in 1964.

Mineral Commodities of Maryland

by

Jonathan Edwards, Jr.

MARYLAND GEOLOGICAL SURVEY

Bedrock formations suitable for crushed stone resources are present throughout the Piedmont and Appalachian regions of Maryland. Consolidated rocks suitable for crushed stone do not occur in the Coastal Plain.

Mafic Igneous and Metamorphic Rocks

Mafic igneous (those which have a large proportion of magnesium and iron-bearing minerals) and metamorphic rocks (those of the former which have undergone changes due to natural pressures) are present in the eastern Piedmont from the Pennsylvania state line southwestward to the Potomac River west of Washington, D. C. Such rocks include basalt, gabbro, serpentine, and mafic gneiss. These rocks make aggregate stone of excellent quality because of their toughness, uniformity of texture, and inert chemical nature.

Basalt (diabase) of Triassic age occurs in large tabular masses, called sills, in western Montgomery County and in extreme northern Frederick County. Many small, elongated dikes of basalt also occur in the Piedmont region, but these are usually too small to be of economic importance.

Gabbro and related ultramafic rocks are present in a wide belt from western Cecil County, through central Harford County, to eastern Baltimore County. Large bodies of gabbro also occur in eastern Harford County, and in southern Baltimore and eastern Howard counties. Several small bodies are present in northeastern Cecil County.

Elongated bodies of serpentine occur from the Pennsylvania state line in western Cecil County, across northern Harford County, northern Baltimore County, and central Howard County, to central Montgomery County. Some serpentine occurs with the ultramafic rocks associated with gabbros.

Mafic gneiss occurs in eastern Harford County and in Montgomery County, west of Washington, D. C.

Granitic Igneous and Metamorphic Rocks

Granitic rocks have a composition high in silicic minerals, such as quartz and feldspar, and include granite, granodiorite, diorite, and granitic gneiss. In general, these rocks are coarser-grained than the mafic rocks and contain minerals such as micas and feldspar which cleave easily. Consequently, these rocks do not make as good aggregate stone as do the tougher mafic rocks.

Like the mafic rocks, the granitic rocks occur throughout the eastern Piedmont region from the Delaware state line in Cecil County, southwestward to Montgomery County and Washington, D. C. The largest mass of granitic rocks is the quartz diorite gneiss present throughout Cecil County and extending across Harford County to eastern Baltimore County. Other bodies of quartz diorite occur from eastern Montgomery County to Washington, D. C. Small bodies of granite occur in southern Baltimore County and in eastern Howard County.

Limestone and Dolomite

Limestone and dolomite are bedded sedimentary formations and occur from Frederick County westward to Garrett County. Although these rocks are not as tough as the mafic rocks, they make excellent crushed stone when either thick-bedded or massively-bedded because of the ease of crushing and uniformity of texture and composition.

The largest areas of occurrence are the Frederick Valley of Frederick County and the Hagerstown Valley of Washington County. Smaller areas of limestone are present in western Washington County, in central and western Allegany County, and in four narrow belts across Garrett County. Limestone and dolomite are covered in more detail in the discussion of Carbonate Rocks.

Crystalline Marbles

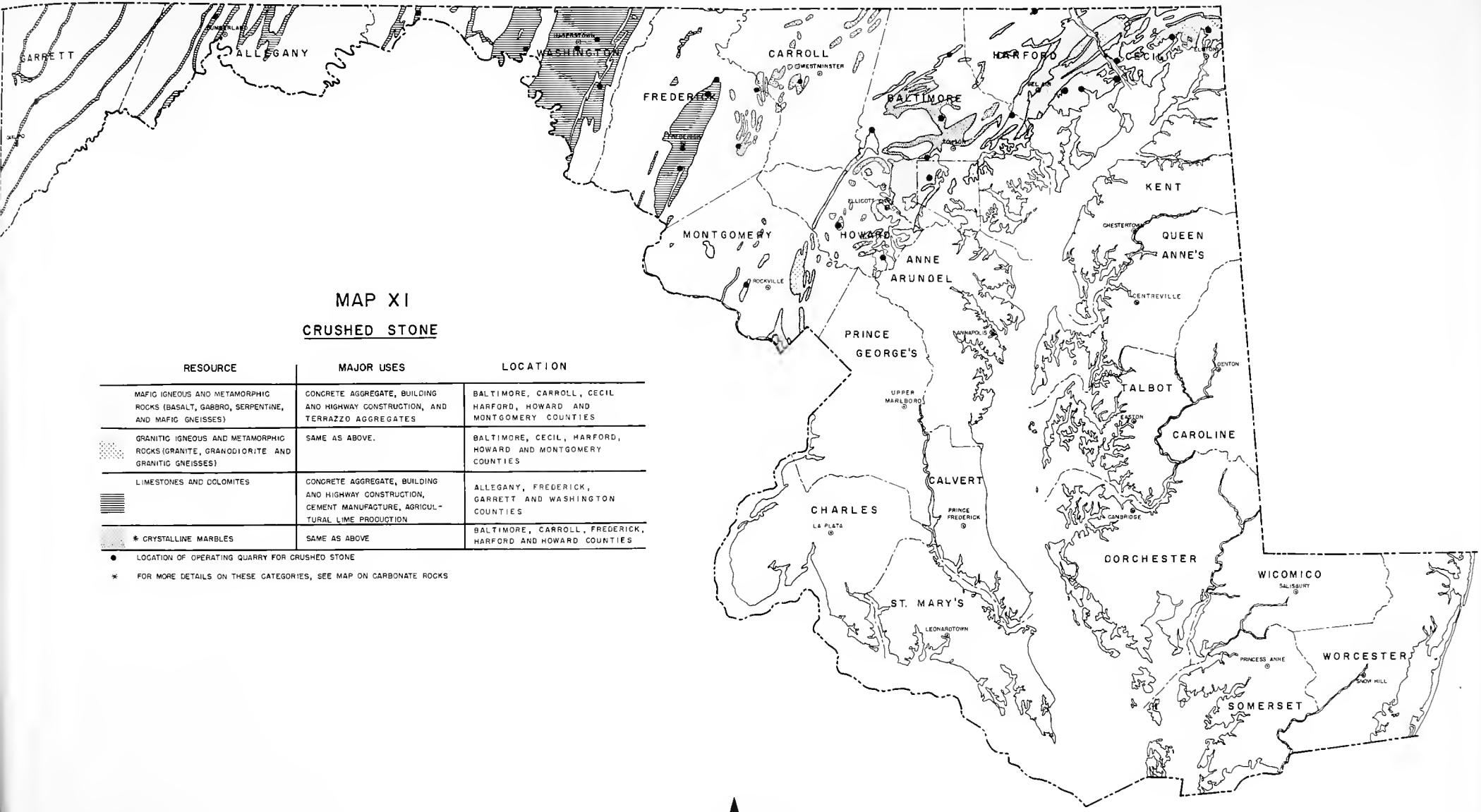
Like the limestone and dolomite of western Maryland, the marble found in the Piedmont region makes aggregate stone of excellent quality. The Cockeysville Marble is present in western Harford, central Baltimore, and central Howard counties, and in the extreme southeastern corner of Carroll County. In many places the rock contains considerable amounts of mica. The Wakefield Marble occurs in narrow, elongated belts of outcrop from central Carroll County to eastern Frederick County. The Silver Run Limestone also occurs in narrow, elongated belts of outcrop and is present northeast of the Wakefield Marble in northern and central Carroll County. This rock contains a considerable amount of quartz and mica and is more properly called a calcareous schist than a limestone. Because of its schistose texture, the Silver Run Limestone may prove to be unsuitable for crushed stone. Crystalline marbles are discussed in more detail under Carbonate Rocks.

SUMMARY

Quartzites and quartzitic sandstones (not shown on map) which occur from Carroll County westward to Allegany County are not currently used for general purpose aggregates because of the relatively high processing cost. These rocks are used primarily in applications where the chemical or physical properties are important, such as in the glass industry or for refractory products. These uses are covered under Miscellaneous Mineral Deposits.

At the present time, the economically most important sources of crushed stone are the mafic rocks and the crystalline marbles in the eastern Piedmont near the large metropolitan centers of Baltimore and Washington, D. C. The Frederick Valley limestones will become increasingly important as the Washington, D. C. metropolitan area expands toward Frederick. Other important

areas are limestones in Allegany County near Cumberland. In the future, the sources of crushed stone underlying land not preempted by suburban development near Baltimore and Washington, D.C. will increase in importance, as will mafic rocks in Harford and Cecil counties which are in the developing corridor between Philadelphia and Baltimore. The granitic rocks in this latter area will probably increase in importance as well.



MAP XI

CRUSHED STONE

RESOURCE	MAJOR USES	LOCATION
MAFIC IGNEOUS AND METAMORPHIC ROCKS (BASALT, GABBRO, SERPENTINE, AND MAFIC GNEISSES)	CONCRETE AGGREGATE, BUILDING AND HIGHWAY CONSTRUCTION, AND TERRAZZO AGGREGATES	BALTIMORE, CARROLL, CECIL HARFORD, HOWARD AND MONTGOMERY COUNTIES
GRANITIC IGNEOUS AND METAMORPHIC ROCKS (GRANITE, GRANODIORITE AND GRANITIC GNEISSES)	SAME AS ABOVE.	BALTIMORE, CECIL, HARFORD, HOWARD AND MONTGOMERY COUNTIES
LIMESTONES AND DOLOMITES	CONCRETE AGGREGATE, BUILDING AND HIGHWAY CONSTRUCTION, CEMENT MANUFACTURE, AGRICULTURAL LIME PRODUCTION	ALLEGANY, FREDERICK, GARRETT AND WASHINGTON COUNTIES
* CRYSTALLINE MARBLES	SAME AS ABOVE	BALTIMORE, CARROLL, FREDERICK, HARFORD AND HOWARD COUNTIES

● LOCATION OF OPERATING QUARRY FOR CRUSHED STONE

* FOR MORE DETAILS ON THESE CATEGORIES, SEE MAP ON CARBONATE ROCKS

10 0 10 20 30 40 50 MILES

1967

COMPILED BY MARYLAND GEOLOGICAL SURVEY,

IN COOPERATION WITH MARYLAND STATE PLANNING DEPARTMENT

THE PREPARATION OF THIS MAP WAS FINANCIALLY AIDED THROUGH A FEDERAL GRANT FROM THE DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT, UNDER THE URBAN PLANNING ASSISTANCE PROGRAM AUTHORIZED BY SECTION 701 OF THE HOUSING ACT OF 1954, AS AMENDED

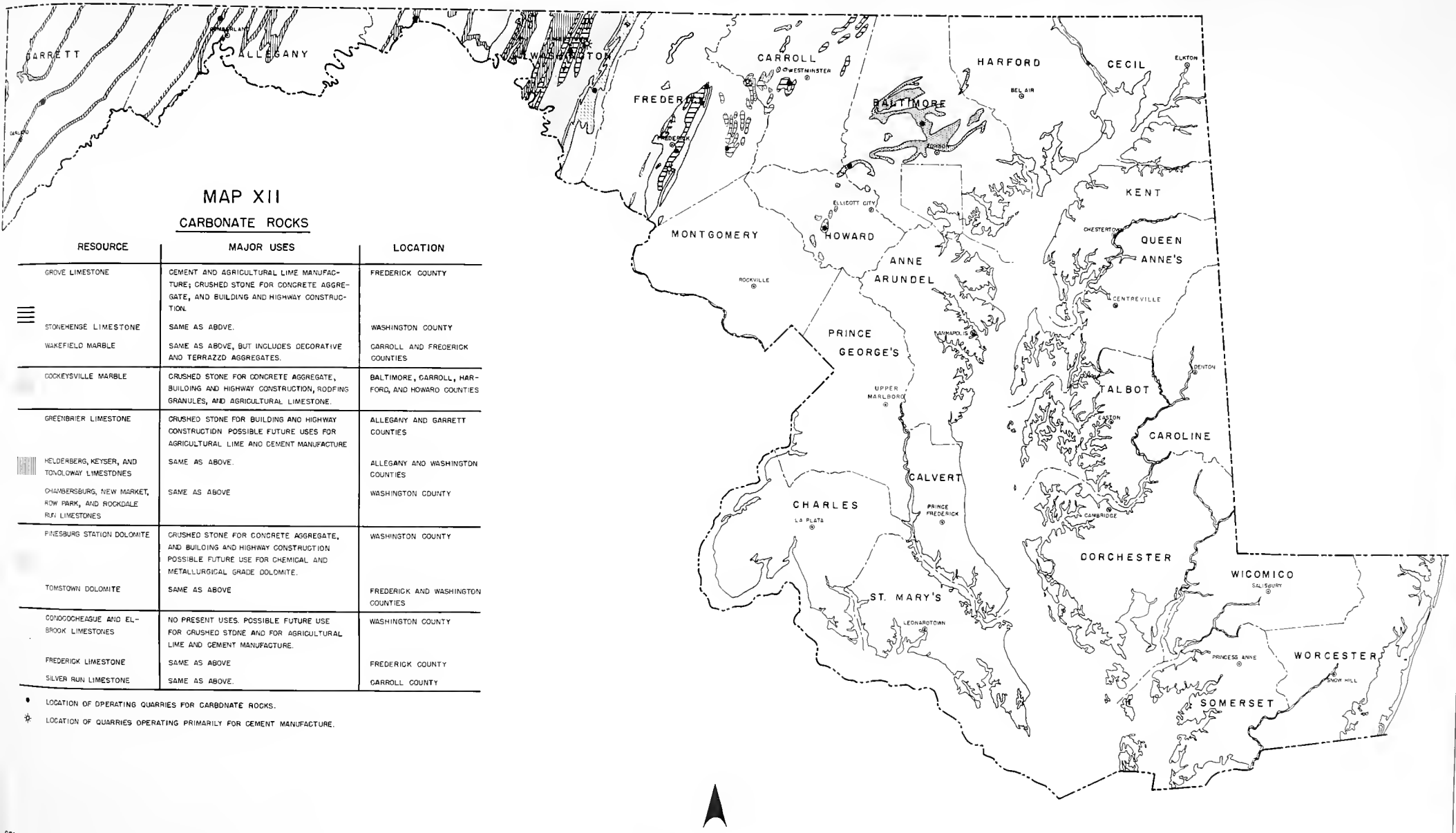
The Cockeysville Marble crops out in a large area of central Baltimore County, and also in smaller areas in Carroll, Harford, and Howard counties. This rock ranges in composition from a pure calcite marble to a dolomite marble, and in many places it contains much mica. The major use for the rock is crushed stone, but the pure calcite marble is used for roofing granules and white aggregate, and in a finely-ground form, as white mineral filler and agricultural limestone. Some types may be pure enough for chemical use. Production of the Cockeysville Marble in the future very likely will be limited to the areas presently being worked, in that the area of occurrence of this formation is close to the Baltimore metropolitan area and is rapidly becoming covered with suburban development.

Limestone formations which are being extracted at the present time for crushed stone are found in the three western Maryland counties of Allegany, Garrett, and Washington. The Greenbrier Limestone occurs in narrow belts of outcrop which extend across Garrett and western Allegany counties. The Helderberg, Keyser, and Tonoloway Limestones occur together in several similar belts from central Washington County to western Allegany County. The Chambersburg, New Market, Row Park, and Rockdale Run Limestones all occur in the Hagerstown Valley of Washington County. These formations are in the region of folded rocks in the Appalachian Mountains and are comprised of moderately- to steeply-dipping beds. It is possible that in some localities any one of these formations may be of sufficient quality for use in cement or agricultural lime manufacture, or as chemical grade stone.

The Pinesburg Station Dolomite, present in the Hagerstown Valley portion of Washington County, and the Tomstown Dolomite in eastern Washington County, are also used at the present time as crushed stone. Two small areas of outcrop of the Tomstown Dolomite are also present in Frederick County, southwest

of Frederick. It is possible that in some localities these dolomite formations in Washington and Frederick counties may have a purity suitable for chemical or metallurgical grade dolomite.

Carbonate rocks not utilized at present include the Conococheague and Elbrook Limestones in Washington County, the Frederick Limestone in Frederick County, and the Silver Run Limestone in Carroll County. These formations are in general too thin-bedded or too schistose for use as crushed stone or else their chemical composition renders them unsuitable for sources of lime or cement. It is possible that locally some of these rocks may be of better quality, but it is unlikely that they will be utilized so long as better sources of stone exist.



MAP XII

CARBONATE ROCKS

RESOURCE	MAJOR USES	LOCATION
GROVE LIMESTONE	CEMENT AND AGRICULTURAL LIME MANUFACTURE; CRUSHED STONE FOR CONCRETE AGGREGATE, AND BUILDING AND HIGHWAY CONSTRUCTION.	FREDERICK COUNTY
STONEHENGE LIMESTONE	SAME AS ABOVE.	WASHINGTON COUNTY
WAKEFIELD MARBLE	SAME AS ABOVE, BUT INCLUDES DECORATIVE AND TERRAZZO AGGREGATES.	CARROLL AND FREDERICK COUNTIES
COCKEYSVILLE MARBLE	CRUSHED STONE FOR CONCRETE AGGREGATE, BUILDING AND HIGHWAY CONSTRUCTION, ROOFING GRANULES, AND AGRICULTURAL LIMESTONE.	BALTIMORE, CARROLL, HARFORD, AND HOWARD COUNTIES
GREENBRIER LIMESTONE	CRUSHED STONE FOR BUILDING AND HIGHWAY CONSTRUCTION POSSIBLE FUTURE USES FOR AGRICULTURAL LIME AND CEMENT MANUFACTURE	ALLEGANY AND GARRETT COUNTIES
HELDERBERG, KEYSER, AND TONOLOWAY LIMESTONES	SAME AS ABOVE.	ALLEGANY AND WASHINGTON COUNTIES
CHAMBERSBURG, NEW MARKET, ROW PARK, AND ROCKDALE RUN LIMESTONES	SAME AS ABOVE	WASHINGTON COUNTY
PINESBURG STATION DOLOMITE	CRUSHED STONE FOR CONCRETE AGGREGATE, AND BUILDING AND HIGHWAY CONSTRUCTION POSSIBLE FUTURE USE FOR CHEMICAL AND METALLURGICAL GRADE DOLOMITE.	WASHINGTON COUNTY
TOMSTOWN DOLOMITE	SAME AS ABOVE	FREDERICK AND WASHINGTON COUNTIES
CONOCOCHEAGUE AND ELBROOK LIMESTONES	NO PRESENT USES. POSSIBLE FUTURE USE FOR CRUSHED STONE AND FOR AGRICULTURAL LIME AND CEMENT MANUFACTURE.	WASHINGTON COUNTY
FREDERICK LIMESTONE	SAME AS ABOVE	FREDERICK COUNTY
SILVER RUN LIMESTONE	SAME AS ABOVE.	CARROLL COUNTY

• LOCATION OF OPERATING QUARRIES FOR CARBONATE ROCKS.

☼ LOCATION OF QUARRIES OPERATING PRIMARILY FOR CEMENT MANUFACTURE.

10 0 10 20 30 40 50 MILES

1967

COMPILED BY MARYLAND GEOLOGICAL SURVEY,

IN COOPERATION WITH MARYLAND STATE PLANNING DEPARTMENT

THE PREPARATION OF THIS MAP WAS FINANCIALLY AIDED THROUGH A FEDERAL GRANT FROM THE DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT, UNDER THE URBAN PLANNING ASSISTANCE PROGRAM AUTHORIZED BY SECTION 701 OF THE HOUSING ACT OF 1954, AS AMENDED

SAND AND GRAVEL

Sand and gravel in economically extractable deposits occur throughout most of the Coastal Plain in eastern Maryland. In the remainder of the State, sand and gravel deposits are limited to terrace deposits and local alluvial deposits in the flood plains of the larger streams which drain the area.

Sand of Pleistocene to Recent age in the Eastern Shore region occurs as a blanket deposit which has an average thickness of between 35 and 60 feet. Some clay and silt occur with the sand, and very minor amounts of gravel occur as well. In the Western Shore region, gravel and sand of Pleistocene to Recent age occur as depositional terraces flanking the larger streams. These terrace deposits are particularly well-developed along the Patuxent River where the maximum thickness is 60 feet. Here, the coarser gravel occurs near the western edge of the Coastal Plain, and the grain size decreases in a downstream direction where only sand is present. Deposits of sand and gravel of Recent age are dredged from several of the larger streams in the Eastern Shore and Western Shore regions.

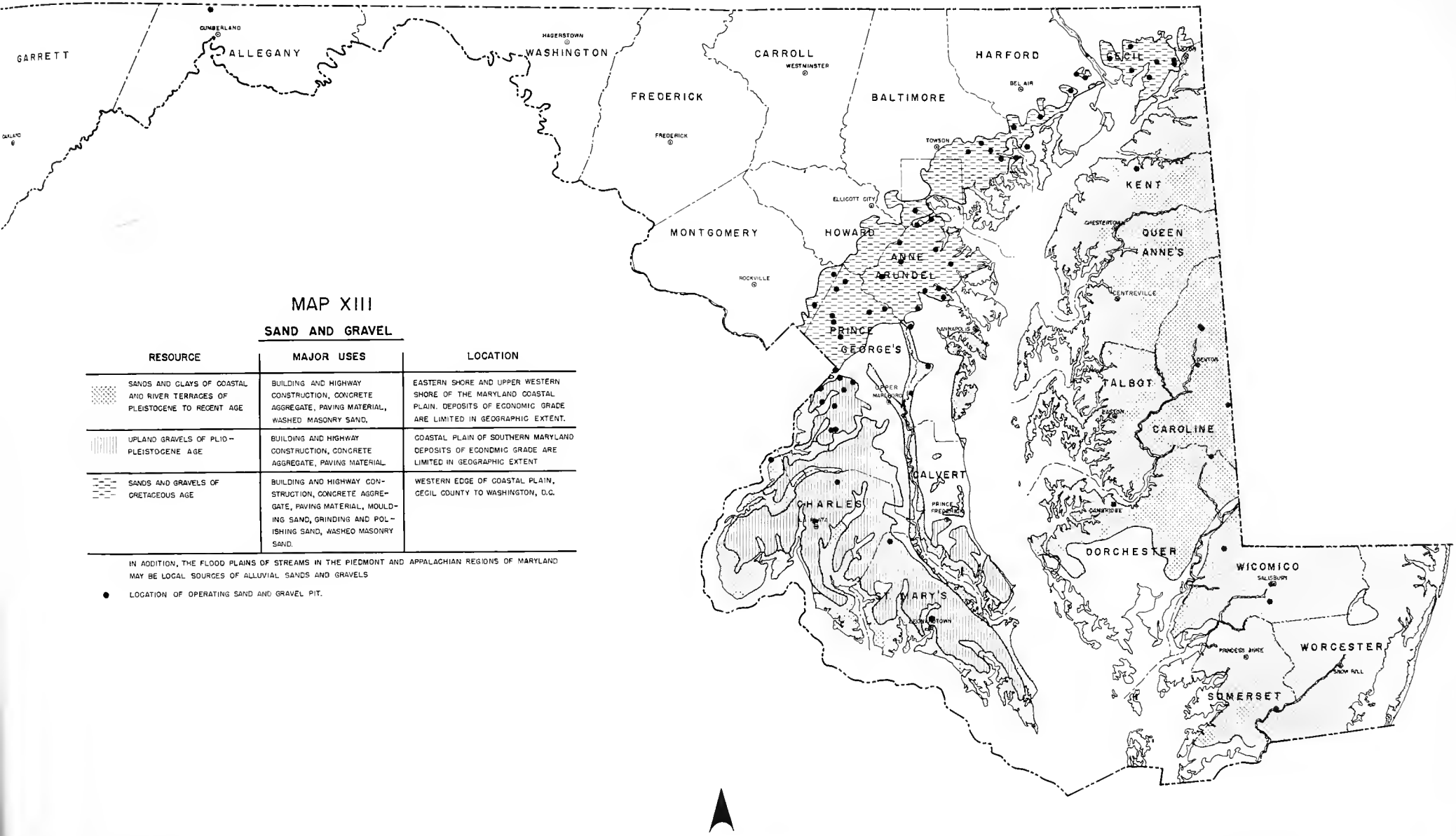
The upland gravel of Plio-Pleistocene age, known as the Brandywine Formation, occurs as a blanket deposit which covers the plateau-like upland surface of Charles, St. Mary's, southern Prince George's, and southern Calvert counties. The formation is from 30 to 60 feet thick. Sand makes up most of the formation, and interstitial clay with iron oxide acts as a cementing agent in parts of the deposit. Lenses of gravel are commonly coarse in Prince George's County, but these decrease both in average grain size and in frequency of occurrence toward the southeast. This gravel has been weathered, but its quality should not be affected for general construction use.

Lenses of sand and gravel of Cretaceous age occur within a broad belt of outcrop which extends from near Elkton, Cecil County, southwestward through Baltimore to Washington, D. C. Generally, sand occurs toward the southeastern

margin of the outcrop belt whereas the gravel lies along the northwestern margin. In many places the best gravel deposits occur along the extreme northwestern edge.

At the present time the economically most important sand and gravel deposits in the State are the Cretaceous deposits in the vicinity of Baltimore and Washington, D. C. Less important are the Pleistocene terraces along the Patuxent River and the deposits located in the Brandywine Formation of Prince George's County. In the future, however, the encroachment of the Baltimore-Washington, D. C. metropolitan complex will preempt the belt of Cretaceous sediments with suburban development unless areas are preserved for mineral extraction by public land use controls. The sand and gravel deposits of the Brandywine Formation will become of prime importance in the future. The river terraces of Pleistocene age along the Potomac River as well as those along the Patuxent River will continue to be important sources of sand and gravel. Cretaceous deposits of sand and gravel in Harford and Cecil counties will increase in importance with the growth of the Baltimore and the Wilmington (Delaware) metropolitan areas.

Present knowledge indicates that gravel deposits of the Eastern Shore region are not as significant as those of the Western Shore Coastal Plain since they occur as thin lenses within the overall blanket of sand. Further exploration for gravel deposits will be needed to meet the increasing demand for construction materials as the Eastern Shore develops.



MAP XIII

SAND AND GRAVEL

RESOURCE	MAJOR USES	LOCATION
SANDS AND CLAYS OF COASTAL AND RIVER TERRACES OF PLEISTOCENE TO RECENT AGE	BUILDING AND HIGHWAY CONSTRUCTION, CONCRETE AGGREGATE, PAVING MATERIAL, WASHED MASONRY SAND.	EASTERN SHORE AND UPPER WESTERN SHORE OF THE MARYLAND COASTAL PLAIN. DEPOSITS OF ECONOMIC GRADE ARE LIMITED IN GEOGRAPHIC EXTENT.
UPLAND GRAVELS OF PLIO-PLEISTOCENE AGE	BUILDING AND HIGHWAY CONSTRUCTION, CONCRETE AGGREGATE, PAVING MATERIAL	COASTAL PLAIN OF SOUTHERN MARYLAND DEPOSITS OF ECONOMIC GRADE ARE LIMITED IN GEOGRAPHIC EXTENT
SANDS AND GRAVELS OF CRETACEOUS AGE	BUILDING AND HIGHWAY CONSTRUCTION, CONCRETE AGGREGATE, PAVING MATERIAL, MOULDING SAND, GRINDING AND POLISHING SAND, WASHED MASONRY SAND.	WESTERN EDGE OF COASTAL PLAIN, CECIL COUNTY TO WASHINGTON, D.C.

IN ADDITION, THE FLOOD PLAINS OF STREAMS IN THE PIEDMONT AND APPALACHIAN REGIONS OF MARYLAND MAY BE LOCAL SOURCES OF ALLUVIAL SANDS AND GRAVELS

● LOCATION OF OPERATING SAND AND GRAVEL PIT.

10 0 10 20 30 40 50 MILES

1967

COMPILED BY MARYLAND GEOLOGICAL SURVEY,

IN COOPERATION WITH MARYLAND STATE PLANNING DEPARTMENT

THE PREPARATION OF THIS MAP WAS FINANCIALLY AIDED THROUGH A FEDERAL GRANT FROM THE DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT, UNDER THE URBAN PLANNING ASSISTANCE PROGRAM AUTHORIZED BY SECTION 701 OF THE HOUSING ACT OF 1954, AS AMENDED

CLAYS AND SHALES

Clays and shales occur throughout Maryland. They have been classified on the accompanying map on the basis of the economic importance of present and potential uses.

Brick clay is found throughout the eastern part of the State and as far west as Washington County. Clay lenses occur as widely-separated bodies within the blanket of Pleistocene sand on the Eastern Shore. The New Oxford Formation and Gettysburg Shale, which occur in Carroll, Frederick, and Montgomery counties also may be used for the manufacture of terra cotta pipe and tile products. Although weathered shale is most desirable from the standpoint of ease of extraction, unweathered material also is suitable for use. A considerable number of sandstone beds are present within the New Oxford Formation, but the Gettysburg Shale in northern Frederick County contains relatively few interbedded sandstones. In Washington County, the weathered Martinsburg Shale long has been used for brick manufacture. The unweathered shale serves as a raw material in the manufacture of Portland cement and also may be suitable for lightweight aggregate.

Clay bodies of Cretaceous age occur as lenses in the Potomac Group, which crops out from near Elkton, Cecil County, to Washington, D. C. These clay lenses have a wide range in quality which determines whether they may be used best for the manufacture of building brick, fire brick, refractories, or terra-cotta pipe and tile products.

Fire clay which occurs as bedded deposits within the coal basins of western Maryland is used for fire brick and other refractory products. The most extensive bodies of fire clay are found with the Pottsville Formation. Other shale formations within the coal basins may have future value in the manufacture of brick or lightweight aggregate.

A dark gray shale unit occurs within the Frederick Limestone in Frederick County and is used by a plant at Woodsboro for the manufacture of lightweight aggregate. Due to repetition by folding, the shale is present in 5 steeply-dipping belts of outcrop along the eastern side of the Frederick Valley.

Clay and shale formations not utilized at the present time are the St. Mary's Formation, the Marlboro Clay Member of the Nanjemoy Formation, the Rockwell Shale Member of the Pocono Formation, shales of Devonian age in western Maryland, and the Peach Bottom Slate.

The St. Mary's Formation in southern Calvert and St. Mary's counties has potential use in the manufacture of lightweight aggregate. The overburden of Pliocene and Pleistocene deposits is not too thick to preclude profitable extraction on the Western Shore. However, on the Eastern Shore Pleistocene sediments are much thicker, and where the St. Mary's Formation is present in the subsurface it is below sea level.

The Marlboro Clay Member of the Nanjemoy Formation, outcropping in Anne Arundel, Prince George's, and northern Charles counties, has possibilities for use in the manufacture of brick and terra cotta products. Commercial use will be limited to the area of outcrop, as the thickness of overburden is too great to be economically removed. The clay dips gently to the southeast.

The Rockwell Shale Member of the Pocono Formation crops out on the top of Town Hill in Allegany County and along the top of Sideling Hill in Washington County, and may possibly be used in the manufacture of lightweight aggregate. However, its rather remote location may place it at an economic disadvantage to other sources of lightweight aggregate.

Shales of Devonian age occur throughout a large area of western Maryland from central Washington County to western Allegany County. These shales may have a future use in brick manufacture, particularly where they have been weathered. The shales are interbedded with sandstone and siltstone, and they have been folded throughout the area of occurrence. The fact that these formations are located rather far from large population centers may preclude their use for some time.

The Peach Bottom Slate in northern Harford County has been used in the past for roofing slate and is suitable for the production of roofing granules. The weathered slate may be usable for lightweight aggregate, but results of firing tests have not been very encouraging.

In addition to these clay and shale units, localized deposits of residual clay have been utilized in the past for brick manufacture in central and western Maryland. These clay deposits overlie marble or limestone bedrock.

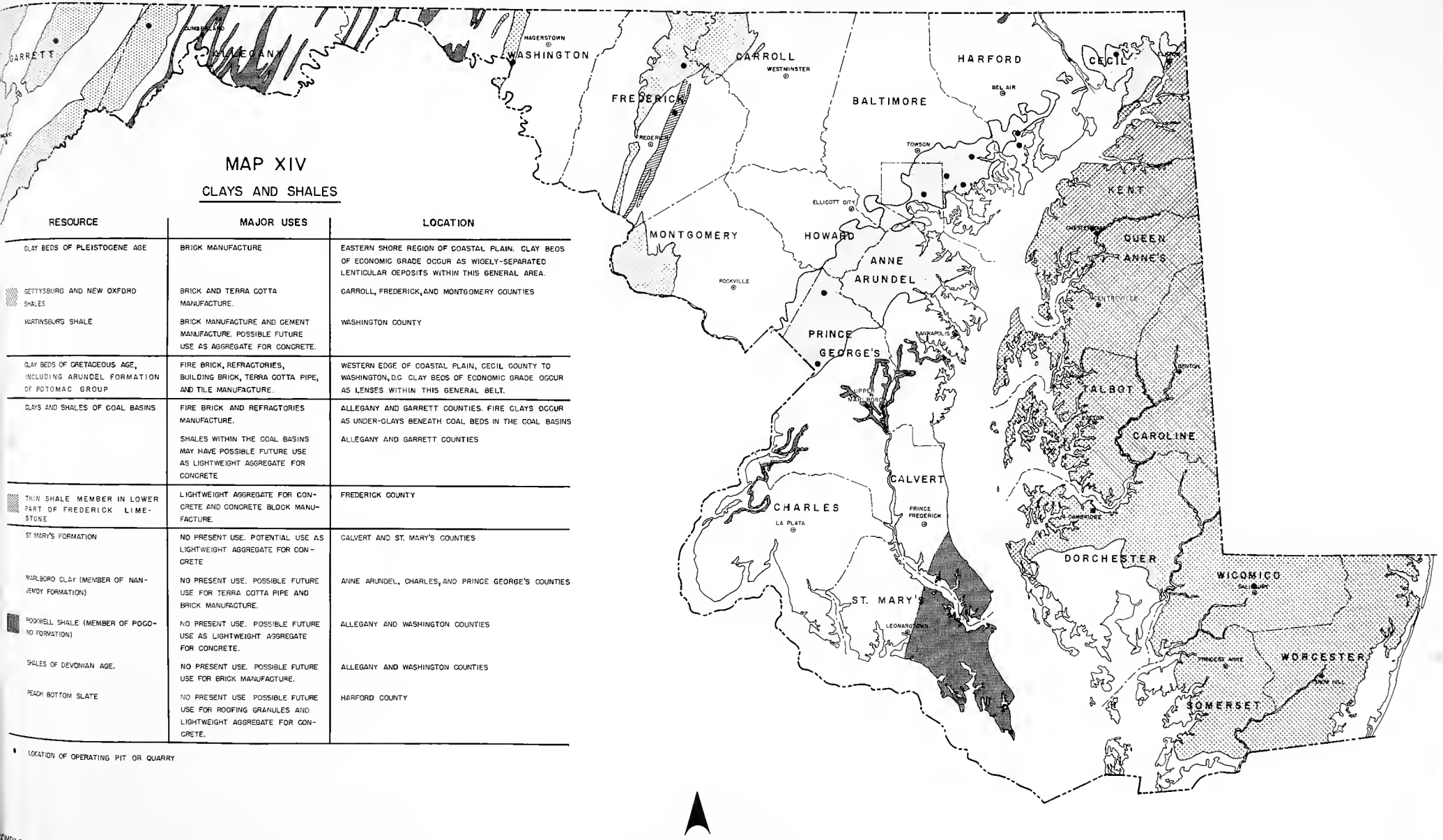
At the present time, the economically most important sources of clay and shale in Maryland are the clay deposits of Cretaceous age near the Baltimore and Washington, D. C. metropolitan areas. However, as these metropolitan areas expand, the surrounding land areas will be preempted by suburban development unless mineral deposits are preserved by public land use controls. Clay and shale formations which will increase in importance as metropolitan areas expand are the New Oxford Formation and Gettysburg Shale in Carroll, Frederick, and Montgomery counties, and the Marlboro Clay in Anne Arundel, Prince George's, and Charles counties. Development of the Eastern Shore region will require further exploration to locate additional deposits of Pleistocene clay. The Martinsburg Formation, in Washington County, and shales of Devonian age may increase in economic importance with future development of the western Maryland counties.

MAP XIV

CLAYS AND SHALES

RESOURCE	MAJOR USES	LOCATION
CLAY BEDS OF PLEISTOCENE AGE	BRICK MANUFACTURE	EASTERN SHORE REGION OF COASTAL PLAIN. CLAY BEDS OF ECONOMIC GRADE OCCUR AS WIDELY-SEPARATED LENTICULAR DEPOSITS WITHIN THIS GENERAL AREA.
GETTYSBURG AND NEW OXFORD SHALES	BRICK AND TERRA COTTA MANUFACTURE.	CARROLL, FREDERICK, AND MONTGOMERY COUNTIES
MARTINSBURG SHALE	BRICK MANUFACTURE AND CEMENT MANUFACTURE. POSSIBLE FUTURE USE AS AGGREGATE FOR CONCRETE.	WASHINGTON COUNTY
CLAY BEDS OF CRETACEOUS AGE, INCLUDING ARUNDEL FORMATION OF POTOMAC GROUP	FIRE BRICK, REFRACTORIES, BUILDING BRICK, TERRA COTTA PIPE, AND TILE MANUFACTURE.	WESTERN EDGE OF COASTAL PLAIN, CECIL COUNTY TO WASHINGTON, D.C. CLAY BEDS OF ECONOMIC GRADE OCCUR AS LENSES WITHIN THIS GENERAL BELT.
CLAYS AND SHALES OF COAL BASINS	FIRE BRICK AND REFRACTORIES MANUFACTURE.	ALLEGANY AND GARRETT COUNTIES. FIRE CLAYS OCCUR AS UNDER-CLAYS BENEATH COAL BEDS IN THE COAL BASINS
	SHALES WITHIN THE COAL BASINS MAY HAVE POSSIBLE FUTURE USE AS LIGHTWEIGHT AGGREGATE FOR CONCRETE	ALLEGANY AND GARRETT COUNTIES
THIN SHALE MEMBER IN LOWER PART OF FREDERICK LIMESTONE	LIGHTWEIGHT AGGREGATE FOR CONCRETE AND CONCRETE BLOCK MANUFACTURE.	FREDERICK COUNTY
ST. MARY'S FORMATION	NO PRESENT USE. POTENTIAL USE AS LIGHTWEIGHT AGGREGATE FOR CONCRETE	CALVERT AND ST. MARY'S COUNTIES
MARLBORO CLAY (MEMBER OF NANJEMOY FORMATION)	NO PRESENT USE. POSSIBLE FUTURE USE FOR TERRA COTTA PIPE AND BRICK MANUFACTURE.	ANNE ARUNDEL, CHARLES, AND PRINCE GEORGE'S COUNTIES
ROCKWELL SHALE (MEMBER OF POGONO FORMATION)	NO PRESENT USE. POSSIBLE FUTURE USE AS LIGHTWEIGHT AGGREGATE FOR CONCRETE.	ALLEGANY AND WASHINGTON COUNTIES
SHALES OF DEVONIAN AGE.	NO PRESENT USE. POSSIBLE FUTURE USE FOR BRICK MANUFACTURE.	ALLEGANY AND WASHINGTON COUNTIES
PEACH BOTTOM SLATE	NO PRESENT USE POSSIBLE FUTURE USE FOR ROOFING GRANULES AND LIGHTWEIGHT AGGREGATE FOR CONCRETE.	HARFORD COUNTY

• LOCATION OF OPERATING PIT OR QUARRY



10 0 10 20 30 40 50 MILES

1967

COMPILED BY MARYLAND GEOLOGICAL SURVEY,

IN COOPERATION WITH MARYLAND STATE PLANNING DEPARTMENT

THE PREPARATION OF THIS MAP WAS FINANCIALLY AIDED THROUGH A FEDERAL GRANT FROM THE DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT, UNDER THE URBAN PLANNING ASSISTANCE PROGRAM AUTHORIZED BY SECTION 701 OF THE HOUSING ACT OF 1954, AS AMENDED

MINERAL FUELS

Mineral fuels produced in Maryland are natural gas and coal, both of which occur in the western part of the State. No oil has been found in Maryland, although three deep test wells have been drilled on the Eastern Shore, with no oil or gas shows recorded.

Natural gas occurs in Garrett and Allegany counties, but at the present time only one field (the Mountain Lake Park field in southern Garrett County) is producing. The recently discovered Negro Mountain field in northern Garrett County currently is being developed for production. The Green Ridge field in northeastern Allegany County is an extension of a producing field in southern Bedford County, Pennsylvania.

The Accident field in northwestern Garrett County was formerly a producing gas field, but it is being converted into a gas storage field. A buried structure near Brandywine in southern Prince George's County has been proposed for use as a gas storage field for the Washington, D. C. metropolitan area.

Areas of Maryland in which natural gas may be found in the future include Washington County west of the Bear Pond Mountains and virtually all of Allegany and Garrett counties. This is the general area of occurrence of the Oriskany Sandstone, which is the reservoir rock for all existing natural gas fields in the State.

Coal is present in Garrett and western Allegany counties, in five elongated, trough-shaped basins known as the George's Creek, Upper Potomac, Castleman, Lower Youghiogheny, and Upper Youghiogheny basins. The greatest number of workable coal seams are in the George's Creek basin, but many of the better seams have been mined out. Workable coal seams are those seams which have a thickness

greater than 28 inches, and which have a low percentage of ash and a high heat generating characteristic. Current recoverable reserves are as follows:*

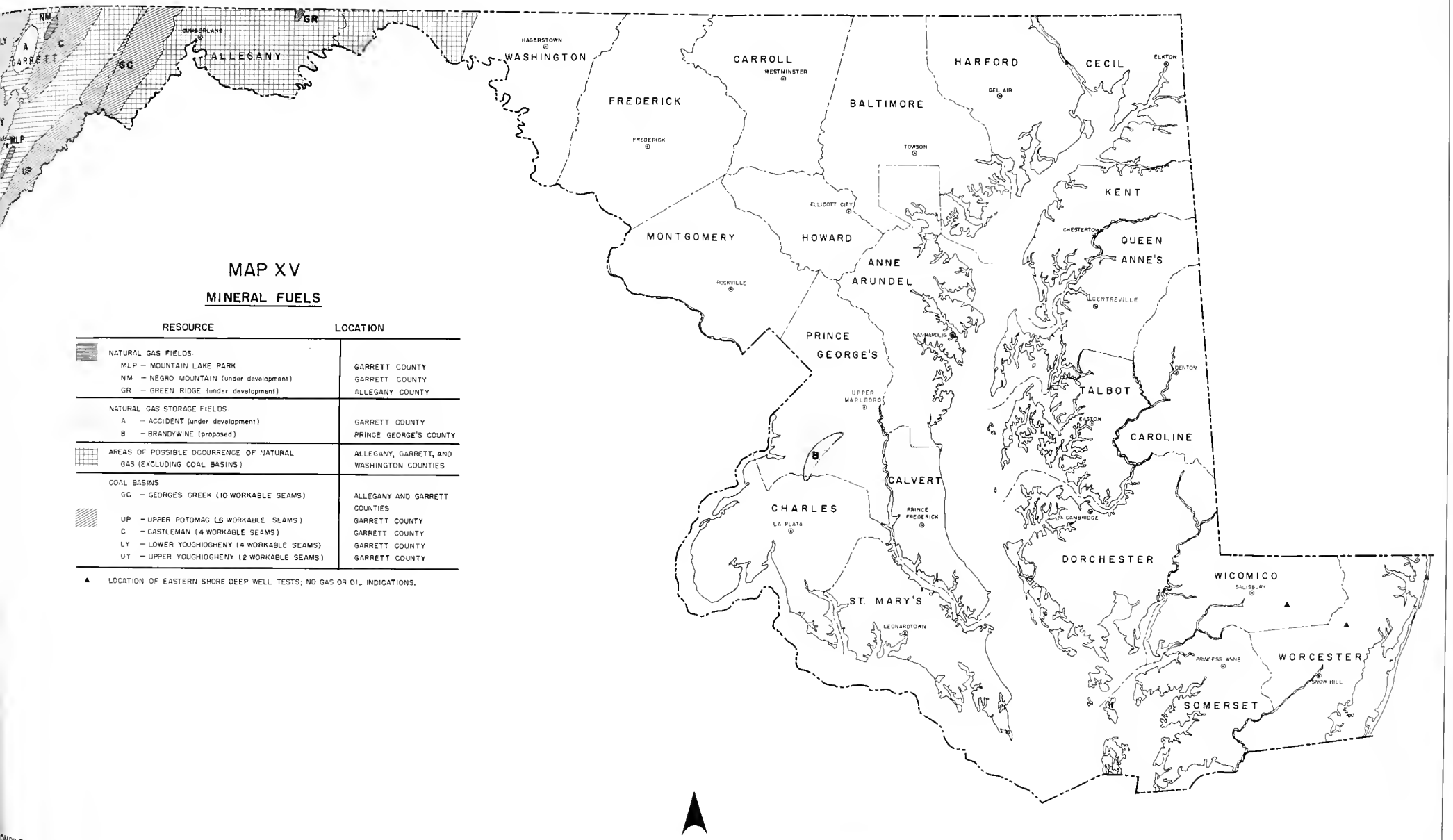
Coal Basin	Deep Tons	Strip Tons
George's Creek	247,821,265	20,464,718
Upper Potomac	170,889,331	12,768,228
Castleman	38,038,487	5,924,670
Lower Youghiogheny**	23,300 acres	1,640 acres
Upper Youghiogheny**	23,300 acres	1,640 acres

Peak production of coal in Maryland occurred in 1907 when 5,632,628 tons were mined. The lowest volume of production since 1907 was 441,895 tons in 1954. Since 1963, the volume of production has exceeded 1,000,000 tons per year. In 1965, production of coal in Maryland was 1,195,787 tons. Strip-mined coal accounted for 63 percent of this total. More stringent Federal and State laws governing strip mining and reclamation methods may render strip mining unprofitable in some areas of the coal basins. Future economic conditions or technology may make it feasible to mine coal seams which at the present time are considered too thin or of too poor quality to be economically workable.

---

* Data from Boyd report (see Selected References).

** No data available for these basins on which to base calculations for reserves tonnages.



MAP XV

MINERAL FUELS

RESOURCE	LOCATION
NATURAL GAS FIELDS:	
MLP – MOUNTAIN LAKE PARK	GARRETT COUNTY
NM – NEGRO MOUNTAIN (under development)	GARRETT COUNTY
GR – GREEN RIDGE (under development)	ALLEGANY COUNTY
NATURAL GAS STORAGE FIELDS:	
A – ACCIDENT (under development)	GARRETT COUNTY
B – BRANDYWINE (proposed)	PRINCE GEORGE'S COUNTY
AREAS OF POSSIBLE OCCURRENCE OF NATURAL GAS (EXCLUDING COAL BASINS)	ALLEGANY, GARRETT, AND WASHINGTON COUNTIES
COAL BASINS	
GC – GEORGES CREEK (10 WORKABLE SEAMS)	ALLEGANY AND GARRETT COUNTIES
UP – UPPER POTOMAC (6 WORKABLE SEAMS)	GARRETT COUNTY
C – CASTLEMAN (4 WORKABLE SEAMS)	GARRETT COUNTY
LY – LOWER YOUGHIOGHENY (4 WORKABLE SEAMS)	GARRETT COUNTY
UY – UPPER YOUGHIOGHENY (2 WORKABLE SEAMS)	GARRETT COUNTY

▲ LOCATION OF EASTERN SHORE DEEP WELL TESTS; NO GAS OR OIL INDICATIONS.

10 0 10 20 30 40 50 MILES

1967

OMPILED BY MARYLAND GEOLOGICAL SURVEY,

N COOPERATION WITH MARYLAND STATE PLANNING DEPARTMENT

THE PREPARATION OF THIS MAP WAS FINANCIALLY AIDED THROUGH A FEDERAL GRANT FROM THE DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT, UNDER THE URBAN PLANNING ASSISTANCE PROGRAM AUTHORIZED BY SECTION 701 OF THE HOUSING ACT OF 1954, AS AMENDED

MISCELLANEOUS MINERAL DEPOSITS

The miscellaneous mineral deposits represent only a very small proportion of the total value of mineral production in Maryland. Some minerals included in this category are not produced at the present time, but possibilities exist for future production.

Talc and Soapstone

Talc and soapstone occur as small discontinuous masses within the serpentine bodies which extend across the Piedmont region from the Pennsylvania State Line in northern Cecil County southwestward to central Montgomery County. Future production of these materials is not expected to increase significantly over that of the present. The two current operations are located at Dublin, Harford County, and at Marriottsville, Carroll County.

High-Silica Sand

The Tuscarora Sandstone is quarried at Cumberland, Allegany County, primarily for use as glass sand, but a portion of the production is utilized as construction sand and for the manufacture of ferrosilicon. The Oriskany Sandstone, although not quarried for glass sand in Maryland, is productive in adjacent states. These two sandstone formations are exposed along the crests or flanks of ridges from central Washington County to western Allegany County. In Maryland, outcrops of the Oriskany Sandstone are more numerous than those of the Tuscarora Sandstone.

The Raritan Formation in the upper part of the Potomac Group is present in the Coastal Plain of Maryland from Cecil County to the Potomac River in Prince George's County. However, at the present time the Raritan Formation is known to attain a quality pure enough for glass sand only in Anne Arundel County.

The Pottsville Formation occurs in the coal basins of Allegany and Garrett counties and contains quartzose sandstone and conglomerate in the lower part of the formation which may be of a quality suitable for products requiring high-silica sand.

In the future, it is probable that the importance of the Oriskany Sandstone for glass sand will increase. It is also possible that the Pottsville Formation will increase in importance because of its proximity to the large centers of glass manufacture in West Virginia and Pennsylvania. The Raritan Formation in eastern Maryland may become important as a source of sand for glass or other products requiring high purity sand.

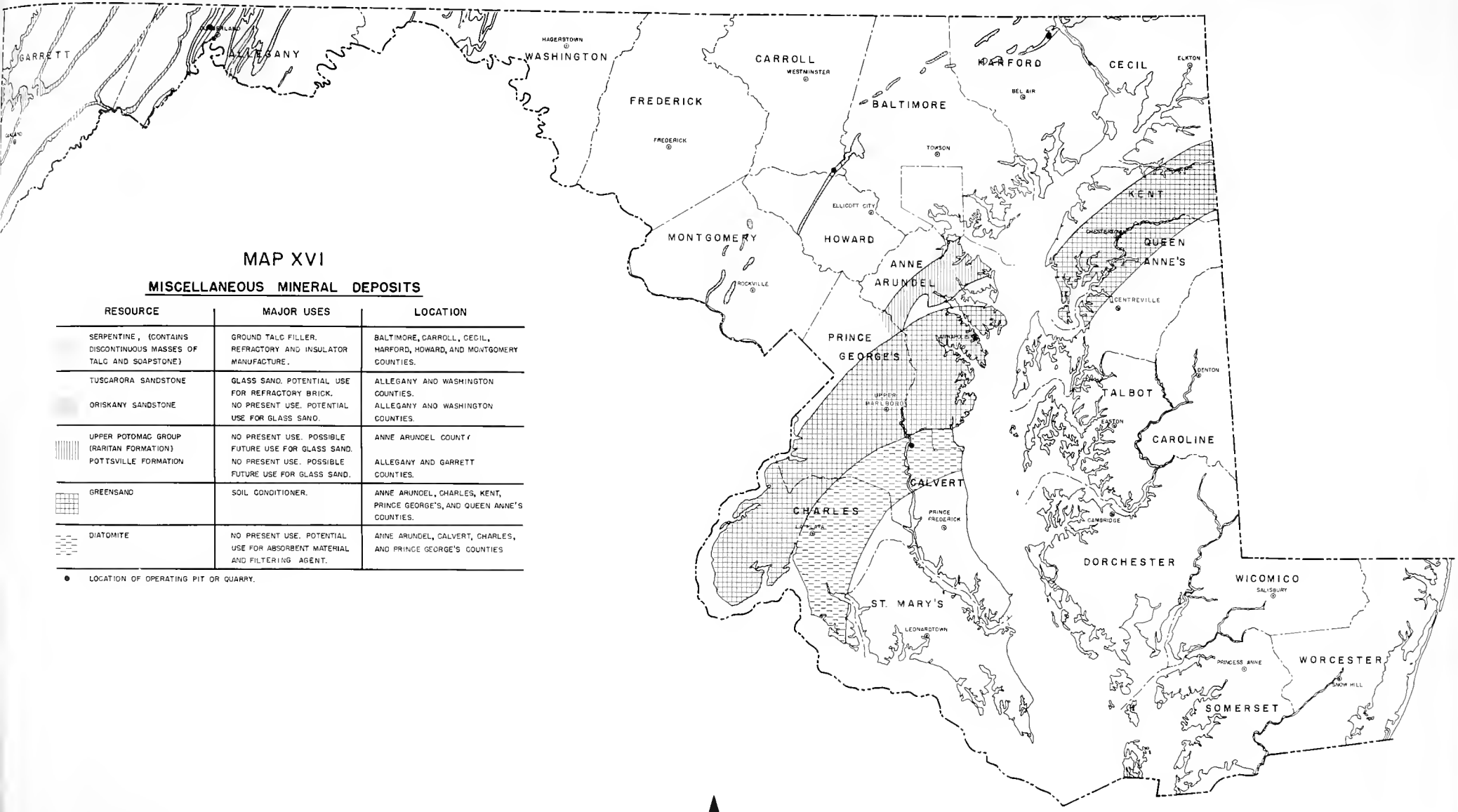
Greensand

Greensand, composed primarily of the mineral glauconite, occurs in the Aquia and Nanjemoy Formations which crop out in a broad belt from Kent County to Charles County. At present, Maryland greensand is used as a soil conditioner. Glauconite is mined in New Jersey for use as a water softener. At some future time, glauconite may serve as a source of potash if economical methods are developed for its extraction.

Diatomite

Diatomite occurs as a 20-foot thick bed in the basal Calvert Formation in Calvert, Prince George's, and Charles counties. As the formation dips to the southeast, the thickness of overburden in that direction becomes too great to be removed economically. Diatomite can be used as a filtering agent, as an absorbent material, or as a mineral filler.

At present, most domestic diatomite comes from the West Coast, primarily from California. Lesser amounts are produced from Nevada, Washington, Arizona, and Oregon. There is no production from the Maryland deposits. Maryland diatomite contains more clay than the western deposits, but considering the



MAP XVI

MISCELLANEOUS MINERAL DEPOSITS

RESOURCE	MAJOR USES	LOCATION
SERPENTINE, (CONTAINS DISCONTINUOUS MASSES OF TALC AND SOAPSTONE)	GROUND TALC FILLER. REFRACTORY AND INSULATOR MANUFACTURE.	BALTIMORE, CARROLL, CECIL, HARFORD, HOWARD, AND MONTGOMERY COUNTIES.
TUSCARORA SANDSTONE	GLASS SAND. POTENTIAL USE FOR REFRACTORY BRICK.	ALLEGANY AND WASHINGTON COUNTIES.
ORISKANY SANDSTONE	NO PRESENT USE. POTENTIAL USE FOR GLASS SAND.	ALLEGANY AND WASHINGTON COUNTIES.
UPPER POTOMAC GROUP (RARITAN FORMATION)	NO PRESENT USE. POSSIBLE FUTURE USE FOR GLASS SAND.	ANNE ARUNDEL COUNTY
POTTSVILLE FORMATION	NO PRESENT USE. POSSIBLE FUTURE USE FOR GLASS SAND.	ALLEGANY AND GARRETT COUNTIES.
GREENSAND	SOIL CONDITIONER.	ANNE ARUNDEL, CHARLES, KENT, PRINCE GEORGE'S, AND QUEEN ANNE'S COUNTIES.
DIATOMITE	NO PRESENT USE. POTENTIAL USE FOR ABSORBENT MATERIAL AND FILTERING AGENT.	ANNE ARUNDEL, CALVERT, CHARLES, AND PRINCE GEORGE'S COUNTIES

● LOCATION OF OPERATING PIT OR QUARRY.

COMPILED BY MARYLAND GEOLOGICAL SURVEY,
IN COOPERATION WITH MARYLAND STATE PLANNING DEPARTMENT

10 0 10 20 30 40 50 MILES

1967

THE PREPARATION OF THIS MAP WAS FINANCIALLY AIDED THROUGH A FEDERAL GRANT FROM THE DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT, UNDER THE URBAN PLANNING ASSISTANCE PROGRAM AUTHORIZED BY SECTION 701 OF THE HOUSING ACT OF 1954, AS AMENDED

cost of transport from the West Coast, it may be possible that the cost of processing the Maryland diatomite would be sufficiently low to make it competitive for eastern markets.

Selected References

Crushed Stone

Cloos, E., 1951, Mineral resources of Washington County, in The physical features of Washington County: Maryland Dept. Geology, Mines, and Water Resources, p. 164-178.

Hopson, C. A., 1964, The crystalline rocks of Howard and Montgomery Counties, in The geology of Howard and Montgomery Counties: Maryland Geol. Survey, p. 27-215.

Mathews, E. B., 1898, An account of the character and distribution of Maryland building stones together with a history of the quarrying industry: Maryland Geol. Survey, v. 2, pt. 2-b, p. 125-241.

_____, 1902, The mineral resources of Cecil County, in Cecil County report: Maryland Geol. Survey, p. 195-226.

Mathews, E. B., and Watson, E. H., 1929, The mineral resources of Baltimore County, in Baltimore County report: Maryland Geol. Survey, p. 219-304.

Singewald, J. T., Jr., 1946, Mineral resources of Carroll and Frederick Counties, in The physical features of Carroll County and Frederick County: Maryland Dept. Geology, Mines, and Water Resources, p. 132-162.

Carbonate Rocks

Amsden, T. W., 1954, Geology of Garrett County, in Geology and water resources of Garrett County: Maryland Dept. Geology, Mines, and Water Resources, Bull. 13, p. 1-116.

Clark, W. B., and others, 1900, The mineral resources of Allegany County, in Allegany County report: Maryland Geol. Survey, p. 165-194.

Cloos, E., 1951, Mineral resources of Washington County, in The physical features of Washington County: Maryland Dept. Geology, Mines, and Water Resources, p. 164-178.

de Witt, W., Jr., and Colton, G. W., 1964, Bedrock geology of the Evitts Creek and Pattersons Creek Quadrangles, Maryland, Pennsylvania, and West Virginia: U. S. Geological Survey, Bull. 1173, 90 p.

Hopson, C. A., 1964, The crystalline rocks of Howard and Montgomery Counties, in The geology of Howard and Montgomery Counties: Maryland Geol. Survey, p. 27-215.

Mathews, E. B., and Grasty, J. S., 1910, The limestones of Maryland: Maryland Geol. Survey, v. 8, pt. 3, p. 225-484.

Mathews, E. B., and Watson, E. H., 1929, The mineral resources of Baltimore County, in Baltimore County report: Maryland Geol. Survey, p. 219-304.

McCue, J. B., Lucke, J. B., and Woodward, H. P., 1939, Limestones of West Virginia: West Virginia Geol. Survey, v. 12, 560 p.

Neuman, R. B., 1951, St. Paul Group: a revision of the "Stones River" group of Maryland and adjacent states: Geol. Soc. AmericanBull., v. 62, no. 3, p. 267-324.

O'Neill, B. J., Jr., 1964, Limestones and dolomites of Pennsylvania: Pennsylvania Geol. Survey, Atlas of Mineral Resources, Bull. M 50, pt. 1, 40 p.

Sando, W..J., 1957, Beekmantown Group (Lower Ordovician) of Maryland: Geol. Soc. America memoir 68, 161 p.

Singewald, J. T., Jr., 1946, Mineral resources of Carroll and Frederick Counties, in The physical features of Carroll County and Frederick County: Maryland Dept. Geology, Mines, and Water Resources, p. 132-162.

Stose, A. J., and Stose, G. W., 1946, Geology of Carroll and Frederick Counties, in The physical features of Carroll County and Frederick County: Maryland Dept. Geology, Mines, and Water Resources, p. 11-131.

Sand and Gravel

Darton, N. H., 1939, Gravel and sand deposits of eastern Maryland: U. S. Geological Survey, Bull. 906-A, 42 p.

Hack, J. T., 1955, Geology of the Brandywine area and the origin of the upland of Southern Maryland: U. S. Geological Survey, Prof. Paper 267-A, 41 p.

Jordan, R. R., 1964, Columbia (Pleistocene) sediments of Delaware: Delaware Geol. Survey, Bull. 12, 59 p.

Otton, E. G., 1955, Ground-water resources of the Southern Maryland Coastal Plain: Maryland Dept. Geology, Mines, and Water Resources, Bull. 15, 347 p.

Overbeck, R. M., and Slaughter, T. H., 1958, The ground-water resources, in The water resources of Cecil, Kent, and Queen Annes Counties: Maryland Dept. Geology, Mines, and Water Resources, Bull. 21, p. 1-382.

Rasmussen, W. C., and Slaughter, T. H., 1955, The ground-water resources, in The water resources of Somerset, Wicomico, and Worcester Counties: Maryland Dept. Geology, Mines, and Water Resources, Bull. 16, p. 1-171.

_____, 1957, The ground-water resources, in The water resources of Caroline, Dorchester, and Talbot Counties: Maryland Dept. Geology Mines, and Water Resources, Bull. 18, p. 1-371.

Schlee, John, 1957, Upland gravels in Southern Maryland: Geol. Soc. America Bull., v. 68, no. 10, p. 1371-1410.

Clays and Shales

Clark, W. B., and others, 1900, The mineral resources of Allegany County, in Allegany County report: Maryland Geol. Survey, p. 165-194.

Cloos, E., 1951, Mineral resources of Washington County, in The physical features of Washington County: Maryland Dept. Geology, Mines, and Water Resources, p. 164-178.

Dryden, L., and Overbeck, R. M., 1948, Detailed geology, in The physical features of Charles County: Maryland Dept. Geology, Mines, and Water Resources, p. 29-76.

Fisher, G. W., 1964, The Triassic rocks of Montgomery County, in The geology of Howard and Montgomery Counties; Maryland Geol. Survey, p. 10-17.

Knechtel, M. M., Hamlin, H. P., and, Hosterman, J. W., 1966, Expandable clay in St. Marys Formation of Southern Maryland: Maryland Geol. Survey, Rept. Invest. 4, 17 p.

Little, H. P., 1917, The mineral resources of Anne Arundel County, in Anne Arundel County report: Maryland Geol. Survey, p. 119-132.

Martin, G. C., 1902, The mineral resources of Garrett County, in Garrett County report: Maryland Geol. Survey, p. 183-232.

Mathews, E. B., 1902, The mineral resources of Cecil County, in Cecil County report: Maryland Geol. Survey, p. 195-226.

Mathews, E. B., and Watson, E. H., 1929, The mineral resources of Baltimore County, in Baltimore County report: Maryland Geol. Survey, p. 219-304.

Miller, B. L., 1907, The economic resources of St. Marys County, in St. Marys County report: Maryland Geol. Survey, p. 113-124.

_____, 1911, The mineral resources of Prince Georges County, in Prince Georges County report: Maryland Geol. Survey, p. 137-150.

Ries, Heinrich, 1902, Report on the clays of Maryland: Maryland Geol. Survey, v. 4, pt. 3, p. 203-503.

Stose, A. J., and Stose, G. W., 1946, Geology of Carroll and Frederick Counties, in The physical features of Carroll County and Frederick County: Maryland Dept. Geology, Mines, and Water Resources, p. 11-131.

Waage, K. M., 1950, Refractory clays of the Maryland coal measures: Maryland Dept. Geology, Mines, and Water Resources, Bull. 9, 182 p.

Watts, A. S., and others, 1922, The fire clays of Maryland: Maryland Geol. Survey, v. 11, pt. 2, 248 p.

Mineral Fuels

Amsden, T. W., 1954, Geology of Garrett County, in Geology and water resources of Garrett County: Maryland Dept. Geology, Mines, and Water Resources, Bull. 13, p. 1-116.

Boyd, J. T., and Associates, 1964, Coal possibilities in Garrett and Allegany Counties, State of Maryland: Unpub. consultant's report, J. T. Boyd and Associates, Mining Engineers, Pittsburgh, Pennsylvania.

Clark, W. B., and others, 1900, The mineral resources of Allegany County, in Allegany County report: Maryland Geol. Survey, p. 165-194.

Clark, W. B., and others, 1905, Report on the coals of Maryland: Maryland Geol. Survey, v. 5, pt. 4, 219-651.

Fairbanks, W. L., and Hamill, W. S., 1932, The coal-mining industry of Maryland: Maryland Development Bureau, Baltimore Association of Commerce, Baltimore, Maryland, 271 p.

Martin, G. C., 1902, The mineral resources of Garrett County, in Garrett County report: Maryland Geol. Survey, p. 183-232.

Maryland Board of Natural Resources, 1963, Department of Geology, Mines, and Water Resources, in Maryland Board of Natural Resources 20th annual report: Annapolis, Maryland, p. 120-139.

_____, 1964, Maryland Geological Survey, in Maryland Board of Natural Resources 21st annual report: Annapolis, Maryland, p. 123-144.

_____, 1965, Maryland Geological Survey, in Maryland Board of Natural Resources 22nd annual report: Annapolis, Maryland, p. 112-128.

_____, 1966, Maryland Geological Survey, in Maryland Board of Natural Resources 23rd annual report: Annapolis, Maryland, p. 122-140.

Slaughter, T. H., 1962, The ground-water resources, in The water resources of Allegany and Washington Counties: Maryland Dept. Geology, Mines, and Water Resources, Bull. 24, p. 1-244.

Swartz, C. K., and Baker, W. A., 1920, Second report on the coals of Maryland: Maryland Geol. Survey, v. 11, pt. 1, 296 p.

Miscellaneous Mineral Deposits

Clark, W. B., and others, 1900; The mineral resources of Allegany County, in Allegany County report: Maryland Geol. Survey, p. 165-194.

Cloos, E., 1951, Mineral resources of Washington County, in The physical features of Washington County: Maryland Dept. Geology, Mines, and Water Resources, p. 164-178.

Dryden, L., and Overbeck, R. M., 1948, Detailed geology, in The physical features of Charles County: Maryland Dept. Geology, Mines, and Water Resources, p. 29-76.

Hopson, C. A., 1964, The crystalline rocks of Howard and Montgomery Counties, in The geology of Howard and Montgomery Counties: Maryland Geol. Survey, p. 27-215.

Little, H. P., 1917, The mineral resources of Anne Arundel County, in Anne Arundel County report: Maryland Geol. Survey, p. 119-132.

Knechtel, M. M., and Hosterman, J. W., 1965, Outlood for resumption of diatomite mining in southern Maryland and eastern Virginia, in Geological Survey research, 1965: U. S. Geological Survey, Prof. Paper 525-D, p. D151-D155.

Martin, G. C., 1902, The mineral resources of Garrett County, in Garrett County report: Maryland Geol. Survey, p. 183-232.

Mathews, E. B., 1902, The mineral resources of Cecil County, in Cecil County report: Maryland Geol. Survey, p. 195-226.

Mathews, E. B., and Watson, E. H., 1929, The mineral resources of Baltimore County, in Baltimore County report: Maryland Geol. Survey, p. 219-304.

Miller, B. L., 1907, The mineral resources of Calvert County, in Calvert Couhty report: Maryland Geol. Survey, p. 123-134.

_____, 1911, The mineral resources of Prince Georges County, in Prince Georges County report: Maryland Geol. Survey, p. 137-150.

_____, 1926, The mineral resources of Queen Annes County, in Queen Annes County report: Maryland Geol. Survey, p. 81-91.

Singewald, J. T., Jr., 1946, Mineral resources of Carroll and Frederick Counties, in Teh physical features of Carroll County and Frederick County: Maryland Dept. Geology, Mines, and Water Resources, p. 132-162.

Stose, A. J., and Stose, G. W., 1946, Geology of Carroll and Frederick Counties, in The physical features of Carroll County and Frederick County: Maryland Dept. Geology, Mines, and Water Resources, p. 11-131.

Note: The Maryland Department of Geology, Mines, and Water Resources was renamed Maryland Geological Survey in 1964.